MACHINERY.

Vol. 5. **June, 1899.** **No. 10**

THE WASHINGTON MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

IN 1887 the American Society of Mechanical Engineers first met in convention at Washington, D. C. There were then 117 members present, while at the meetings recently held in that city, from May 9 to 12, inclusive, there were 568 names entered upon the register, the largest number at any meeting outside of New York City. This comparison, however, is not a fair one, because formerly only members enrolled their names, while both members and their guests are now expected to register. Assuming that every attending member invited one guest for the earlier meeting, there would still have been less than one-half as many as were in attendance last month, which fact may be taken as indicative, not only of a growing membership and an increasing interest, but of the greater influence, prosperity and usefulness of the society as a whole.

The spring meetings are always enjoyable occasions from a social standpoint, but it is safe to say that the anticipations of all who attended the Washington meeting were not only fulfilled in every respect, but were far exceeded. The society has reason to feel grateful to the local committee, headed by their honored president, which arranged so efficiently for the reception of the members and their friends. Many privileges were granted through the efforts of this committee and these added to the magnificent reception given the society by Mr. and Mrs. George Westinghouse, contributed much to everybody's enjoyment.

The professional papers were of about the average interest, three or four of them evoking a large amount of discussion. The professional meetings were well attended in spite of the numerous attractions from without so that the time in Washington was profitably as well as pleasantly spent.

The first gathering was at an informal reception held in the new Corcoran Gallery of Art, the reception committee comprising Mrs. Westinghouse, and Rear Admiral Melville, and the other officers of the society. The national Marine Band of thirty-five pieces furnished music for the occasion and the acoustic properties of the gallery are so exceptionally good that the music was doubly appreciated. Fully 1,000 people attended, including members of the foreign legations, and the address of welcome was made by Col. T. A. Bingham, U. S. Engineer in Charge of Public Buildings and Grounds, who, it should be said, worked unceasingly for the comfort and pleasure of the visitors, both before and during the convention.

The most notable gathering, as implied above, was the reception given to the engineers Thursday evening by Mr. and Mrs. Westinghouse at their spacious home, which was formerly the James G. Blaine mansion. The palatial residence, although of unusual size, was not large enough to accommodate the guests to whom invitations had been sent and an annex was built 40 x 50 feet to serve as a supper room. This room was a veritable fairyland and has been characterized as the most magnificent interior that has been attempted in Washington for many years. The walls were hung with white silk and festooned with satin ribbon and the superb floral decorations were of orchids and roses arranged in exquisite taste and lighted by myriads of tiny incandescent lamps. The decorations in every room were of great beauty and a constant delight to all who saw them. Over two thousand guests were present, many of them prominent personages in national affairs. This event will go down in the annals of the American Society of Mechanical Engineers as one of the brilliant spots in its history.

A particularly pleasant excursion was made to Mt. Vernon the home of Washington, on Friday afternoon and universal gratification was expressed at the excellent condition in which this noted place is maintained, thanks, it should be said, to the Mt. Vernon Ladies' Association to whom its preservation is due.

Friday evening, visits were made to the Washington monument to view the illuminated city by night and to the Congressional Library, which was specially lighted and opened for inspection after the usual hours of closing. Another excursion was previously made Thursday afternoon to the navy yard and gun factory, where the chief attention seemed to center in the trial tank for ship models. It was the general expression, however, that while the mechanical features of this trip were noteworthy, they were not to be compared in interest to the architectural and artistic features of the library, the beauty and grandure of which completely won the members from things mechanical to another world which was an inspiration, broadening in its effect.

Individual trips, or excursions of small parties were also made to Arlington, the naval observatory, from whence our standard time is observed, and to other points of interest. The White House was open to inspection on Wednesday afternoon and on the same afternoon the society was photographed on the steps of the State, War and Navy Building. An excellent reproduction of the photograph is shown on another page of this issue.

The Professional Meetings.

The first professional meeting was held Wednesday morning at the Arlington, Rear Admiral Melville, president of the society, presiding. The first part of the meeting was devoted to business matters, including the report of the tellers upon the election of new members, and of the finance committee. The past year has been a prosperous one, the receipts amounting to over $3,400 more than the expenditures and the net receipts for the past year have been about $2,500 more than for the previous one, clearly indicating a general prosperity among those engaged in mechanical engineering in its various branches. A request was read from prominent men of Cincinnati that the next spring meeting be held in that city, but no action has yet been taken in the matter. The junior meetings, two of which have been successfully held in New York the past winter, are to be continued throughout next winter.

The Code of 1899 for Conducting Steam Boiler Trials.

After the business details had been attended to the final revision of the report of the committee appointed to formulate a new code relative to standardizing steam boiler trials was made. This code has been mentioned in these columns before, but it may be well to state what it is and what it is for.

It is not within the province of the American Society of Mechanical Engineers to adopt as a body any code of rules for any branch of engineering work. They have from time to time, however, appointed committees to investigate certain branches of engineering and to make a written report with recommendations as to standards, methods, etc. A committee is now at work upon methods for steam engine testing and is studying the practice abroad as well as in this country. In 1885 a similar committee recommended certain rules for testing the capacity and efficiency of steam boilers and furnaces and since that time these rules have been very generally used for boiler trials. During the last thirteen years, however, new forms of calorimeters have been devised for determining the percentage of moisture in steam, as well as the calorific value of coal, increasing attention is paid to the analysis of flue gases and current practice has advanced in other ways. Two years ago a second committee was appointed to revise or add to this code of 1885 and the paper presented at this meeting of the society, was as stated, the final revision. The changes in this code are mainly in the line of amendments, such as the experience of the past few years have

shown to be desirable. The amendments relate mainly to the use of improved steam calorimeters, to sampling coal and determining its moisture, to calorific tests and analysis of coal, to analysis of flue gases, to smoke observations, to determinations of efficiency, and to methods of working out the "heat balance."

In the former code the unit of boiler horse-power adopted was 34½ pounds of water evaporated from a feed-water temperature of 212 degrees Fahr. into steam at the same temperature. The present committee, while not relinquishing this standard recommends that, as far as possible, "the capacity of a boiler be expressed in terms of the number of pounds of water evaporated per hour from and at 212 degrees." Since every pound of water evaporated under these conditions requires 965.7 thermal units, new importance is likely to attach to this quantity. The body of the report is comparatively brief, containing only 18 pages, but it is accompanied by appendices written by different members of the committee and by the discussions upon the report that have previously been made. The whole comprises a pamphlet of over 100 pages which is an exceedingly valuable contribution upon the subject of steam boilers.

Standards for Direct Connected Generating Sets—Other Papers.

Following the report of the committee upon boiler trials came the presentation of the regular papers. The first was by J. B. Stanwood, Cincinnati, upon standards for direct-connected generating sets. He called attention to the improved results in every branch of the machine business from the adoption of standards in the manufacture of the smaller parts and made a strong argument in favor of extending this policy to include some of the main dimensions of the generators and engines that are used together as one generating unit. This type of combined machine has reached what seems to be an established form so that standards can safely be adopted. As made at present, the generator and engine are built by different firms and often specified or designed by a third party. The generator is likely to require a new sole plate for the engine; it has to be a press fit upon the shaft, which is a source of more or less annoyance; and the engine may be required to run at a different speed from that intended. Mr. Stanwood pointed out that a coming together on the part of the electrical and mechanical sides would result in a reduction in the costs and an increased opportunity for foreign orders. He closed his paper with a motion requesting the Council to communicate with the American Institute of Electrical Engineers to ascertain if that institute would agree to appoint a committee to co-operate with a similar committee to be appointed by the American Society of Mechanical Engineers to recommend standards for electric generators for direct connection to steam engines. And if a favorable response be received that the president be requested to appoint a committee to confer with the committee of the Institute of Electrical Engineers. This motion was carried unanimously.

The next paper was upon Boiler and Furnace Efficiency, by R. S. Hale and W. B. Russel, Boston, Mass. The authors contended that a comparison of the efficiencies of boilers as a whole might lead to erroneous and unsatisfactory results, because this efficiency is really made up of three parts comprising the efficiency of combustion, the efficiency of heating surface, and the efficiency of the utilization of the heat, which takes into account the loss from radiation. A large number of tests gathered from various sources were tabulated and analysed on this assumption and among the conclusions drawn were the following:

The horizontal return tubular boilers appear, all things considered, to be the type of boiler for best economy of steam production, although the internally fired boilers are probably as good if the furnace is roomy and the firing careful.

Certain of the water-tube boilers suffer from air leakage and from short circuiting of gases if underworked. Of course the advantages of water-tube boilers often make their choice advisable, even at the possible expense of a slight loss in efficiency.

Stokers save nothing over hand-firing, either in better combustion or less air supply. This does not necessarily apply to all stokers, and it should be remembered that, even if it should finally prove to be true that stokers are no more efficient than hand-firing, yet saving in labor and smoke may pay good returns on their cost.

Mr. Hale, in presenting the paper, said that comparatively few tests were available for this paper, because of the incompleteness of most of them and that therefore some of the conclusions might not be fully warranted. In spite of this statement, however, the paper was quite severely criticised in the discussion, Mr. William Kent even saying that no conclusions whatever could be drawn from the tests since they were made by different men, under different conditions, and with different coals. As might be expected the stoker and water-tube boiler men had something to say and claimed that as only three tests on stokers and four on water-tube boilers were quoted, as against forty tests on shell boilers, the conclusions drawn in the paper were not justified. Mr. Hale, in closing, upheld certain of his conclusions, again calling attention to the fact that no claim was made for completeness in the tests quoted.

The last paper of the meeting was by F. L. Emory, of Morgantown, W. Va., upon a test of a steam separator of a baffle-plate pattern. The tests were to determine the capabilities of the separator as a trap for water and as an oil extractor. The results showed that the separator would deliver steam of 97 per cent. dryness, irrespective of the original quality. The method of measuring the oil separated was not entirely satisfactory, but apparently not over 50 per cent. was extracted.

In commenting on the paper, Mr. F. H. Boyer suggested a method for extracting oil from exhaust steam that his past experience had shown to be efficient. It was to use a tank with a baffle-plate in the bottom, the upper part of the tank being filled with coke. Part of the oil would be thrown down by the baffle-plate and the larger part of the rest would be extracted in passing through the coke. In the course of a month or less the coke could be taken out and burned and a fresh charge put in.

Investigations of Boiler Explosions.

A brief paper upon this subject was presented by Mr. Gus. C. Henning, New York City, at the opening of the next session, which was held Wednesday evening. He made the somewhat striking statement that there does not seem to exist any doubt whatever that the cause of every boiler explosion can be readily determined by one who has correct and sufficient knowledge of the properties of materials. He said, for example, that if a boiler fails through excessive pressure, it is possible to determine the fact by making several tests of strips taken from the boiler, especially when they are of different thicknesses. It is a well-known fact that excess of stress beyond the yield point invariably raises it above its original value, and if, therefore, careful tests be made of the material, especially with an autographic recorder, the results will invariably show augmentation of yield point. Different thicknesses will show different augmentations which must always be in direct proportion to the stress applied. If calculations show that the augmentations of yield point in thick and thin material were produced by the same internal pressure, then it is proof positive that excessive pressure existed at the instant of explosion, and also its exact amount. Tests of stay-bolts will show the same thing. Elongation of the material is, however, reduced by excess of stress, and a second tension test of a piece of material previously ruptured will be very materially decreased. Stress beyond the yield point also changes the shape of the elastic curve in a very characteristic manner.

Again, when an explosion has been due to low water, if the temperature has raised the material to a low or bright red color, this can be readily determined by superficial inspection. While the fire side will show red rust or a black color, the water or steam side will invariably show a typical steel-blue scale, which will not disappear even after years, as it is a so-called rustless coating. If this be once oiled it will always be distinguishable, even if the plates had been exposed to moisture and gases for years. The color of this scale will depend somewhat upon the temperature at which it was produced, being brightest at those points where temperature was the highest. Carefully made tests, with autographic diagrams, of such material will again demonstrate changes of properties, which are very characteristic. The yield point will be found very low, while the diagram will show a material drop of curve just after the yield point. The elongation will, however, as a rule, be materially increased, with a diminution of tenacity. Nicked and quenched bending tests will again show marked differences between strips cut from the sheet at points which in one case were overheated or were above the low-water

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AND THEIR GUESTS, AT WASHINGTON, D. C.

Photo. by Washington Souvenir Co., Washington, D. C.

line, and in the other were taken from a part below this line. The fracture will also be materially different.

In the discussion of this paper Prof. Aldrich, formerly of the repair ship "Vulcan," related his experience in forcing the bulged fire boxes of marine boilers back into place and inquired how often this operation could be safely performed. Mr. Henning replied that while a half dozen or so times might not be dangerous, the repeated practice would result in a change of the elasticity of the material that would be dangerous.

Pipe Flanges and their Bolts.

The paper which drew out the most discussion of the evening was by A. F. Nagle upon pipe flanges and their bolts. He discussed methods for obtaining tight joints in high-pressure steam piping and prepared a table giving dimensions and number and size of bolts for flanges. The number and size of bolts were based upon the tables of the Chapman and Crane valve companies, using in each case the highest values found in either. In his calculations Mr. Nagle assumed that the effective or binding power of a bolt was ten per cent. of the theoretical power and also that the gaskets between the joints were to be one inch wide. He then tried to select a sufficient number of bolts for the flanges to produce a pressure upon the gaskets that would, in his opinion, hold the latter in place under a high internal steam pressure. He finally came to the conclusion that the pressures produced by the bolts are so small that the only safe practice is to use a tongue and groove in the flanges to reduce the bearing area of the gasket and to keep the gasket from being blown out if slightly relieved on one side. He advocated an arrangement of piping which would take up the strains due to expansion and contraction by torsion in the pipe line rather than by any form of transverse stress upon the pipe or its flanges, since flexure produces strains upon a bolted joint which it is not able to withstand without seriously injuring the joint. To this end he proposed a special design of pipe length capable of absorbing tortional strains. It consisted of a thin copper tube riveted to flanges and having longitudinal corrugations. Steel staves or rods also attached to the flanges were placed in the corrugations and the bursting pressure was resisted by external hoops.

In the discussion the president said that his department had experienced more trouble during the Spanish war from leaky pipe joints than from any other single cause. Several gave their preferences in the way of joints, one of the best ones shown being for wrought pipes. In this style the flanges were grooved internally and the pipes were rolled or expanded into the grooves and then flanged over on the outside, the flanged portion of the pipes being the parts that come together and make the joints. The next day Mr. Fritz placed drawings of flanges on the blackboard that he had used successfully. They were of the tongue and groove type, with ends of pipe enlarged so that the tongue and groove could be placed in the pipe and with the flanges screwed on to the pipe.

The other papers of the evening were upon the initial tension and power transmitted by a belt by Prof. F. L. Emery; experiences with deep well pump rods, by Prof. S. W. Bissel, Ames, Ia.; and the manufacture of car wheels by G. R. Henderson, Schenectady, N. Y. The first of these was deeply mathematical and from it we quote the following sentence:

"It is evident that the total pull tending to shorten the distance between the two shafts, or the total stress along the line of centers of shafts, is the same when running as when still, and the only change is in the difference in tension between the two sides."

This statement, while holding for bands which are made, for example, of steel and in which the stress and strain are proportional, has been conclusively proved to be not true by the experiments made by Mr. Wilfred Lewis at William Sellers & Co. several years ago. Mr. Lewis submitted a mathematical discussion of the paper.

The two latter papers mentioned, while of interest to others do not contain material that would be of any considerable value to the readers of this paper.

Tall Building Day.

At the annual meeting of the society held last winter in New York a paper by W. H. Bryan upon the mechanical plant of a modern commercial building attracted considerable attention and it was predicted at that time that it was the beginning of what would be a fruitful subject for discussion in the future. This prediction has proved true, for the committee in charge of the Washington meetings grouped together several papers upon heating plants, elevators, etc., for presentation Thursday morning, thus making a "tall building" day of it. The best laid plans sometimes fail, however, and it seemed necessary to alter the program, placing the paper by John Fritz upon rolling mill fly-wheels in the list for Thursday morning. As this paper was of quite general interest it absorbed a large share of the attention for the morning and the consequence was that seven papers had to be crowded into the closing session Friday morning and the time was too limited to allow them full justice. The heating plant and elevator papers were the following:

Equipment of Tall Office Buildings in New York City, by R. P. Bolton.

The Central Heating Plant of the University of Wisconsin, by Prof. Storm Bull.

The Power Plant of a University, by Prof. E. A. Darling.

The Plunger Elevator, by G. I. Alden.

Elevators, by C. R. Pratt.

Of these, the most elaborate was that by Prof. Darling, which described in great detail, accompanied by many drawings, the new and complete plant of Columbia University, New York This plant is a model; the buildings are new and it was possible to design it on a satisfactory basis from the start.

In marked contrast to this plant is the one at the University of Wisconsin, which, while satisfactory in most respects, is really a remodeled old plant and those in charge were obliged to adopt various compromises and do the best they could under the circumstances without doing the best that might have been possible under other circumstances. The plant at this university is a central one, and considerable discussion arose as to the relative advantages of central plants in general. The arguments for and against central plants and separate units are well known and it is not necessary to repeat them here, although the discussion was of more than usual interest, since, at Admiral Melville's request, it turned upon the advisability of a central power station for the Brooklyn navy yard, where new shops are being built. Prof. Aldrich criticised the Wisconsin plant in the fact that several blowing and other auxiliary engines were installed at different points, when the power might have been generated at one station and transmitted by electricity.

The two papers upon elevators described the plunger elevator made at Worcester, Mass., and the development and construction of the latest type of the Sprague electric elevator, the largest and one of the most recent installations of which was described in our issue of April, last. The Plunger elevator is the well-known form in which the car is raised by a long hydraulic plunger operating in a long cylinder sunk in the ground. This elevator has been used many years for freight and slow-speed passenger service, but it has now been perfected so that it is capable of high speeds and high lifts. At Providence, R. I., a ten-story building is equipped with these elevators for passenger service. In calling attention to the paper Mr. Alden said that two of the earlier difficulties, drilling the deep hole for the cylinder and the inability of the column to withstand the load of the car had been entirely overcome.

Rolling Mill Fly-wheels.

At the last New York meeting of the American Society of Mechanical Engineers Prof. Benjamin's paper describing his experiments upon the bursting strength of fly-wheels attracted a great deal of attention. In the discussion Mr. John Fritz, formerly president of the Bethlehem Iron and Steel Co., described the construction of the fly-wheels that he had used in his rolling mill practice, where the duty is exceptionally severe, without ever having an accident. The paper which Mr. Fritz gave at the Washington meeting described these wheels more fully, and as we shall publish an abstract of it in a later number it will be unnecessary to give it extended notice here. In brief, his successful wheel has sixteen segments and arms, both arms and segments being cored. At the joints the walls of the segments are increased in thickness to compensate for the loss in strength due to the insertion of links to hold the rim together at these joints. At the center the arms are inserted and doweled in a large hub.

The following are some of the salient points of the discussion:

Mr. Oberlin Smith and one or two others argued in favor of

solid rim wheels with pin or sliding joints at the ends of the arms which would allow the rim to act like a simple ring without any bending strains due to centrifugal force on one hand and the holding power of the arms on the other. Mr. Lewis suggested that the same end could be accomplished by putting in initial bending strains when constructing the wheel, which would be relieved when the wheel reached its normal speed if correct calculations had been made. Mr. Stanwood stated that Prof. Benjamin was about to make experiments upon wheels having rims with lugs bolted together in the usual way, but with the lugs placed near the arms at the point of reverse flexure of the rim instead of at the center of the segments.

In conclusion Mr. Fritz contended that the arm joints should be rigid rather than sliding and that solid rim wheels would not be successes except in small sizes. He called particular attention to the necessity for slow cooling of the castings in the foundry. "Put on all the sand you can," he said, " and let the casting stay until cold."

The two remaining papers, which were rushed through Friday morning were upon the Allen Valve for Locomotives by C. H. Quereau, which related to the advantages of the Allen valve when properly applied and A New System of Valves for Steam Engines, Air Engines and Compressors by F. W. Gordon, concerning which we hope to have something to say later. The session closed with resolutions of thanks for the many courtesies shown the society and a set of resolutions favoring improved facilities at the Patent Office. Those who are familiar with this office and know the crowded, dirty and mixed surroundings in which the employees are compelled to labor, can appreciate the force of the latter resolutions.

* * *

TWIST DRILL GRINDER.

The twist drill grinder shown in the accompanying illustration, embodies features that an extended experience with this type of machine has shown to be desirable. Several of these features are novel and we believe will be of interest to our readers.

The first of these is the method of holding the drill, whereby it is claimed that small drills can be held as easily and firmly as large ones. As is usual in these machines the drill rests in a V-shaped holder and the lip that is to be ground bears against a lip rest, which serves to keep the drill from turning and to properly locate the lip for grinding. Unlike most machines, however, the rest is not stationary, but is pivoted so that it stands nearly vertical for small drills and swings back sufficiently to give large drills the proper setting.

In any grinder the axis about which the drill swings must pass to one side of the axis of the drill instead of intersecting it. This construction necessarily throws the end of the drill holder toward the end of the grinding wheel during the first part of its travel, and if sufficient room between the drill holder and wheel is not allowed the two will come in contact, much to the detriment of the holder. The amount by which the end moves toward the wheel changes with the radius of curvature and is small for small drills and proportionately larger for large ones. What it amounts to practically is that the end of the drill holder must be set ⅛th in. further from the wheel for a 2-inch drill than for a ⅛th-in. drill, and to accomplish this a stop is provided which correctly locates the drill holder at all times. This stop effectually prevents the drill holder from being crowded against the wheel, however careless the workman may be, and it has an inclined face which gives the required adjustment automatically, the drill holder striking at a lower point when adjusted for large drills than for small ones.

A difficulty met with in grinding drills is to set the axis about which the holder and drill oscillate at the correct distance from the wheel so as to produce uniform results when grinding drills of the same size. In this machine the adjustment is effected by the aid of the caliper jaws seen in the engraving, one of which is carried by the frame of the machine and the other by the slide which supports the drill holder. By placing the drill to be ground between the two jaws and bringing the jaws together until they bear upon the drill, the holder will be at the correct distance from the wheel for that size of drill and it is very easy to duplicate the setting.

By utilizing these two features the operation of setting the machine is simply to first locate the position of the axis of oscillation by the aid of the caliper jaws and then bring the end of the holder close to the wheel until it bears against the inclined stop mentioned.

Another feature that is of more importance than would appear at first thought is the height of the drill point relative to the wheel when grinding large drills. This point is illustrated in the sketch shown in Fig. 2., in which A B C D represents the face of an emery wheel of the cup form. To secure the best results the lip of the drill to be ground should always be presented

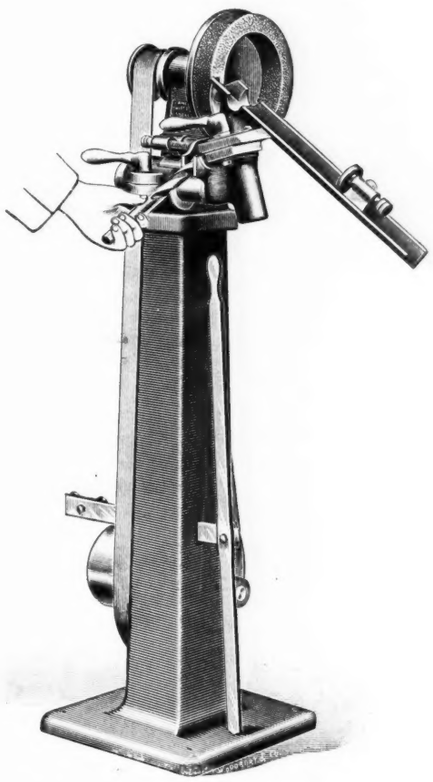

FIG. 1. AMERICAN TWIST DRILL GRINDER.

tangent to the grinding circle LM as indicated by the line XY, as otherwise irregularities in the wheel will produce irregularities in the drill lip. Unless special provision is made to keep all drills at this point it will be found that the drill lip will be in a position more nearly corresponding to the line OZ, and as it is necessary that the lip stand in as nearly a vertical position as possible, it cannot be brought tangent to the grinding circle when thus raised. This trouble is occasioned whenever a large drill is inserted or when the machine is so constructed that the drill holder must be adjusted to or from the wheel on an incline In the machine shown this adjustment is made at right angles to the axis of oscillation, and a little consideration will show that this construction keeps the end of the drill always at the same height with respect to the grinding wheel for all sizes of drills.

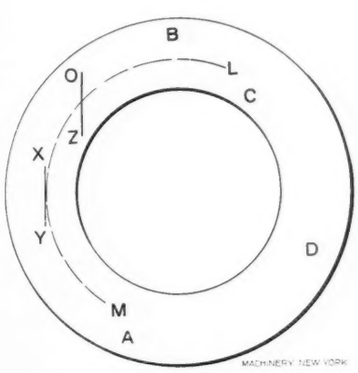

FIG 2.

This machine is called the American twist drill grinder and is made by L. S. Heald and Son, Barre, Mass. It shows careful design and a full knowledge of what are the essential requirements in all its parts.

SOME NOTES FROM A NEWARK SHOP.

BORING TAPER HOLES—SUBSTITUTE FOR A COMPOUND REST—MAKING CAPS FOR ARMOR PIERCING SHELLS—OLD BORING MACHINE, ETC.

The manufacturing industries of Newark, N. J., make it a city of considerable importance in the commercial world and form the chief support of the population which numbers about 225,000. A number of factories are located there that are known throughout the country for their products, such as the Clark O. N. T. thread works, the Marshall linen thread works, the Murphy varnish works and a number of others. Among the machinery builders may be mentioned the Watts & Campbell Co., builders of Corliss engines, the Newark Machine Tool Works and the Gould & Eberhardt Co

Scattered throughout the city are many small shops which are practically unknown, however, to the general public, but which contain much of interest to the mechanic. The writer recently had the privilege of visiting some of these small shops, and one of the notable places for ingenious methods of making ancient and worn-out tools turn out good work is the New Jersey Machine Works. The present proprietors having leased the shop and tools, are running it as a job shop, and evidently do not hesitate to tackle anything that comes their way, even if away beyond the ordinary capacity of their tools. One instance is the facing of a seven-foot disc on an engine lathe of about 30" swing, by reversing the head-stock and rigging up a suitable cross-feed.

They have also had a share of the government work, which was the result of our late unpleasantness with Spain, and were finishing the last of a lot of steel caps for armor piercing shells at the time of my call.

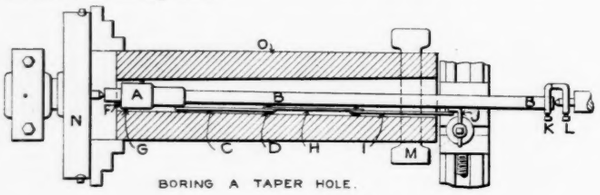

FIG. 1

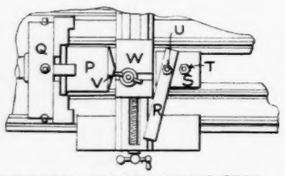

FIG. 2

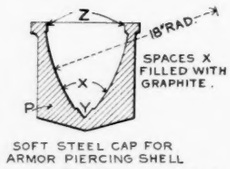

FIG. 3

These caps are made from soft steel of a cross-section like that shown in Fig. 3, and bear the proportion to the shell indicated by the sectional view of the complete shell shown in Fig. 5. The recess X in Fig. 3 is filled with graphite, or black lead as it is quite commonly called, so that when in position on the shell, as in Fig. 5, there is a layer of this unctious substance between the cap and the shell.

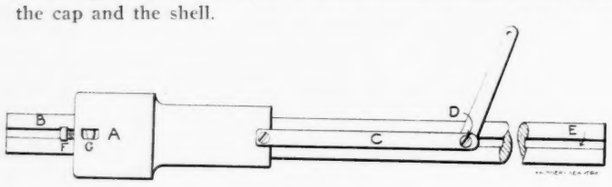

FIG. 4.

The action of one of these shells when striking an armor plate is to split open the soft cap and to start on its destructive path through the plate with its point well smeared with the graphite. The action of the cap is, however, not limited to merely preserving a lubricant on the point of the shell until the moment of impact, but it fulfills another important office.

It will be noted by reference to Fig. 3 that the cap only touches the shell at Z and at the point Y. The soft cap has a similar action on the point of the shell when entering the hardened armor as a cork has on the point of a needle when driven through a copper penny. This interesting experiment which may be new to some readers of MACHINERY, consists of shoving a common sewing needle into a cork so the point nearly protrudes through the opposite side and then laying the cork on the penny with the point of the needle down and striking the head of the needle a quick rap with a hammer. If the experiment be skillfully performed, the point of the needle will be found sticking through the penny. The action of the cork is to support the point of the needle and to keep the shaft from bending under the impulse of the hammer blow thereby concentrating the full effect of the blow on the point.

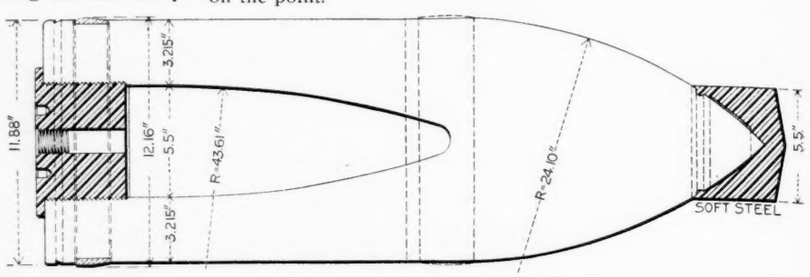

FIG. 5.

The same effect obtains to a limited extent with the soft steel cap and the shell, the point being prevented from swerving to one side until well started through the plate and then the plate has the same action, which therefore tends to its own destruction.

It will be seen that the end of the steel cap is faced off at an angle and in this shop there was no lathe having a compound-rest, so the simple rig shown in Fig. 2 was fixed up to accomplish the same result. The cut is almost self-explanatory and will be readily understood by any machinist. The cast-iron block S was planed on the bottom to fit between the ways of the lathe-bed and a groove was planed across the top at the required angle. The bolts U and T hold the block S and the piece R in place so that the outward travel of the tool-block will push the carriage to the left since it has to follow the direction of the piece R.

The cavity in the cap after being roughed out in the lathe is finished with the reamer, shown in Figs. 6 and 7, and as the results of its work are very smooth and uniform, attention is

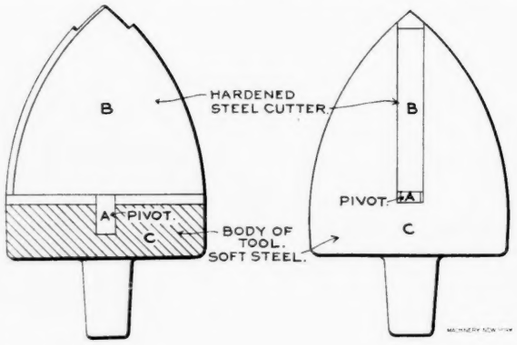

FIG. 6. FIG. 7

called to the peculiarities of its construction. The body of the reamer is of soft steel of the approximate shape of the required cavity and a slot is cut longitudinally of a width of about one-half an inch and to the depth indicated in the cuts 6 and 7. The hardened steel cutter B is formed to the correct shape and laid in the slot without any fastening at all, being a perfectly free fit. The end opposite the point rests on the pivot A, which is a piece of $\frac{3}{8}$" round steel driven into a hole drilled in the body of the reamer and which projects a short distance above the bottom of the slot. It will be seen that the cutter is a floating tool and is free to center itself so that an equal amount is cut by each edge. This is an important point and is probably the secret of the very smooth work turned out. A reamer of this pattern costs only a fraction of what a rose reamer does, is much easier kept in shape and undoubtedly does better work. The sectional view of the cap in Fig. 3 is only approximately correct, as it is evident that the reamer does not cut a larger diameter than that of Z, but the shoulder is indicated so obviously out of place that the recess

for the graphite may be more readily perceived. The sectional view of the 12" shell in Fig. 5, however, shows the exact shape and proportions of the cap and the shell, together with the way the cap is secured to the shell. The shoulder that is turned on the cap and which is indicated in Fig. 3 is rolled down smooth when the parts of the shell are finally assembled, by a special machine which forces a bead into the groove of the shell.

The sectional cut of the shell is of special interest as it is made from a blue-print of the authorized drawings and shows that a comparatively small space is given up to the explosive, also that the chamber approximates in shape that of the exterior of the shell. The space given to the explosive is so small and the thickness of the walls is so great with the armor piercing shell that oftentimes the charge fails to burst it upon impact. The specifications regarding the base plug are very rigid and with good reason as a defective plug would be likely to cause a premature explosion of the shell.

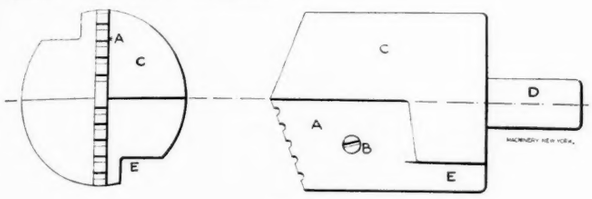

FIG. 8.

The firm recently had a contract for the turning and boring of some steel rolls which are used in textile manufacturing. The rolls are about 7 ft. long and 12" or 15" in diameter, with a hole 4" in diameter clear through. As they are forged solid, it was necessary to drill the hole which was done on a lathe, one-half the depth being drilled from each end. The drill used was one having an inserted blade, as shown in Fig. 8. It will be noted that the cutting edge is fluted or grooved and the grooves are laid out on each edge so that a groove and land will come in the same concentric circle. The evident object of this is to break up the chips so that they can readily pass through the passage E on each side of the head. In the cut, A is the cutter, B is one of the screws holding the cutter to the head C. The shank is held in a socket at the end of the boring bar. A suitable drilling liquid is forced in as the drilling proceeds and washes out the chips besides lubricating the point of the drill.

The writer was shown a rig for boring long taper holes that is so simple and effective that a description of it is given, and it

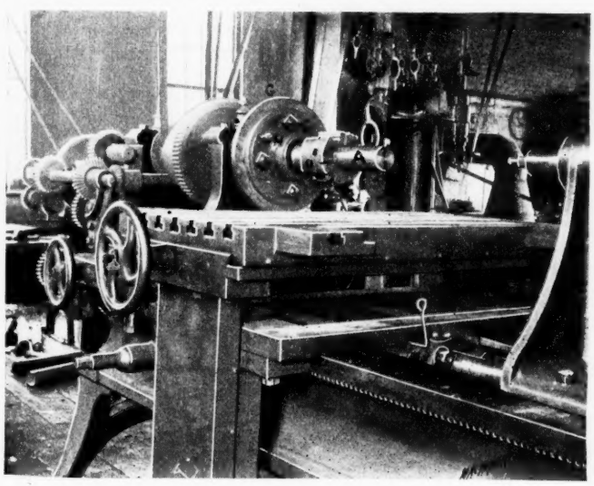

FIG. 9. OLD BORING MACHINE.

will undoubtedly be new to many, but when they understand its operation they will wonder why such a simple trick is not more generally known.

The firm were given the job of making some rolls that were to be mounted on a taper shaft. The two diameters were about 3¼" and 3¾" with a length of 4 feet. The way the job was done is clearly shown in Fig. 1, the work being held in the lathe chuck and supported in the steady rest at the outer end while the boring bar is prevented from rotating by the interlocked lathe dogs at the right. The bar B is held on the centers with the tail-stock set over one-half the amount of the taper the same as in taper turning. The head A is fitted with a feather which slides in the groove E in the usual manner and motion is communicated to the head by the jointed strip C. The reason for the strip being made in sections was that the length of the lathe would not allow the use of anything else. The strips are kept in alignment by the points of the screws being engaged in the

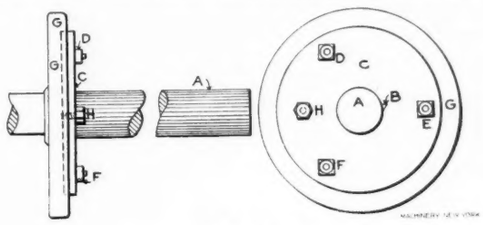

FIG. 10

groove E. In this job the hole was bored so that there was a bearing for only three of four inches at each end, the remainder being relieved to a somewhat larger diameter. This feature, however, was only a matter of detail which could be readily handled. It is obvious, however, that a taper hole can be bored only when the work is rotated as the tool would sweep a circle of uniform diameter in all positions along the bar if it be turned.

Some curiosities in old tools are to be seen in this shop, as many of them are the work of the former owner, and they show

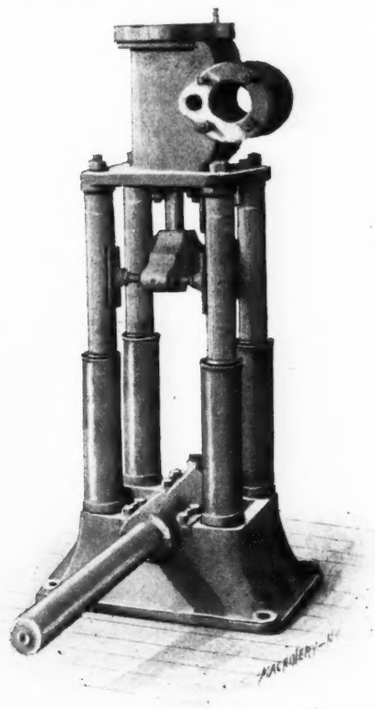

FIG. 11. VERTICAL ENGINE WITH TURNED GUIDES.

some original ideas. The photograph reproduced in Fig. 9 shows a sort of compromise between a lathe and a boring machine. The spindle has a longitudinal traverse of five or six inches, but does not carry any movable bar. The tool was evidently used the same as a lathe when boring long holes, the only advantage being the elevating table, but on short holes that come within the range of the spindle traverse it is still found to be very convenient. As shown in the cut, it is rigged up for boring the cylinders of a vapor engine, which number eight and all in one casting.

For simplicity the engine is constructed with trunk pistons and the cylinder covers are cast in place so in boring the holes the bar can only be supported at one end. The head O is used on the larger diameters, while the tool in the end of the bar A is used on the smaller holes. The counterboring is effected at the inner end by throwing the bar out of alignment with the spindle by slacking the two bolts, D and F, Fig. 10 and tightening up the set-screw H, which has the effect of making

the counterboring tool describe a larger circle. A very slight movement of the screw is sufficient to make a counterbore 1-16" larger than the bore of the cylinder.

Fig. 11 shows a small vertical engine that was in process of erection and which presents something of a novelty in design. The four columns are of cast-iron and are cored for the wrought-iron tie rods which with the nuts show at the upper side of the lower flange of the cylinder. The cast-iron columns are turned at the upper ends and form a bearing for the slipper of the cross-head. The construction of the cross-head can be seen in the cut and its simplicity is evident. The slipper is turned on the outside and bored to the diameter of the columns and is then quartered so that one casting makes the entire slipper. The result of this form of construction is that all the machine work can be done on the lathe which is an important factor in low production cost.

It is evident that the present proprietors possess the faculties of ingenuity and enterprise, and it is likely that before many years pass they will be in a position to throw their antiquated equipment into the scrap pile and replace it with tools that do not require the expenditure of so much valuable "gray matter" in order to obtain results. A visit to a shop of this kind is usually, however, of more interest to a machinist than to one in which the equipment leaves nothing to be desired. F. E. R.

* * *

ANOTHER BRASS FOUNDRY REMINISCENCE.

C. Vickers.

The old foreman of the shop where I received my initiation into the mysteries of the trade, was quite a character. He was a large man, traveling along in the sixties, with gray hair which had once been red, and a broad face tanned by exposure to that shade usually designated as "red as a beet." He had his moods, like the best of us, and when he was in a good temper he was angelic; but when in a bad temper, he was a tyrant. In spite of his temper, however, he could be bluffed and we boys knew it. When in one of his fits he would stride up and down the shop like a caged lion. Everything from politics to the weather, and everybody from the head molder to the chore-boy, came in for a share of his abuse. After a while he usually selected one of the apprentice boys as the especial object of his wrath and would settle down to "watching" him. He would stand at the end of that particular floor, with his arms hanging straight by his sides, nervously clenching and unclenching his fists—and count the molds. Then he would "begin"—the boy was "behind," he was shirking and so on, ad infinitum. His patience exhausted, Mr. Apprentice would spring his stereotyped "bluff." He would throw down his tools, turn his back to the bench, and sit defiantly with folded arms. Then the storm would burst, and having reached its climax, end in this usual manner. The boy would quit, but before he could get out of the shop, which you can rest assured he was in no hurry to do, he would be hired again, and the moral atmosphere being cleared by the storm, there would be peace.

But with all his faults this foreman was a kind-hearted man, and a good mechanic, and if everybody connected with that firm did not know the latter fact, it was not for the want of telling. His especial hobby was metal mixing, and every department foreman that came into the shop was buttonholed, and made to listen to the old, old story, which hinged on the fact that at some time in his history, he (our foreman), had worked in an experimental shop, and through those mysterious metallurgical experiments which had been crowned with success had become possessed of some wonderful secrets, which he would gravely explain, he had "locked up here," tapping the top of his head, and there they were going to stay, and they did stay there for the old fellow carried his wonderful secret to the grave.

Naturally, all this mystery excited the liveliest curiosity in the breasts of us youngsters, and we schemed to obtain possession of such carefully-guarded secrets. Accordingly, I quit pegging at the furnaceman, and labored assiduously to cultivate that worthy's friendship, which was not a difficult task, as he was a good natured soul of a forgiving disposition. So, when the thing was explained he was in for it hand and glove, and this was the result:

Soft brass for general machine fittings: Copper, 86 pounds; tin, 8 pounds; zinc, 4 pounds; lead, 2 pounds. There is a foot-note in my note book which says. "Tested; this is excellent; very good, general red brass." (I do not remember using this mixture, but must have done so. There are many things in my note book that I do not remember—that is what the note book is for).

Hard brass for bearings, etc.: Copper, 86 pounds; tin, 14 pounds; zinc, ½ pound; lead, ½ pound.

Speaking of bearings reminds me that all the bearings made in that shop, and we made great numbers, were cast with the bearing surface up. Theoretically, this is not good practice, as the bearing surface is the part that is wanted sound. If cast uppermost, any dirt held in suspension in the metal will be found there, because, being lighter than the metal, it will rise to the highest part of the mold. This is the reason why it is the general American practice to pour the casting with the bearing surface down. In general practice, however, brass castings are expected to turn out as sound on the top as on the bottom. In circular and other objects that are finished all over, it would be a poor excuse for any dirty or porous places to say that that side was cast uppermost and consequently the dirt in the metal had lodged there. It is not expected that there will be any dirt in the metal that enters the mold, as either the metal must be cleaned before it is poured or the casting so gated that dirt cannot enter the mold. Such being the case, it should not make any difference which side of a casting is poured uppermost, as both sides must be equally clean. The practice of making the castings under consideration with the bearing in this cope, nas several good points that are worthy of consideration; viz.: They are easier to mold, the shrinkage can be controlled better, and they can be poured cooler, thus saving time and labor in chipping. They are more easily molded, because the entire pattern is in the nowel, which need be no deeper than will give a margin of safety against run outs, through the bottom, the cope being comparatively low.

The shrinkage can be more easily controlled because the casting can be gated at its highest point and the diameter of the sprue can be made of sufficient size to feed the casting. We can, therefore, pour the metal at a medium temperature and the sprue, which will be filled last, and is of large size, will remain liquid after the casting has begun to congeal, and so will supply metal to take the place of the volume of the casting lost through shrinkage.

Now, when we mold the bearing down the casting is entirely in this cope. The sprue leads the metal down to the point of this mold, and the casting is therefore run from the bottom, and the metal must rise up into the mold.

To obtain the requisite pressure to ensure the mold filling properly, we require a high head and consequently must have a high cope, which is awkward to handle.

The sand also must be nailed around the pattern before the latter is removed to prevent dropping when closing the mold. This takes time, and if we pour cool, we are likely to find deep shrinkage cracks in the back at the juncture of the flanges and the body of the bearing. The metal must, therefore, be poured at a lively temperature and the casting comes out rougher and with more or less fins, which means so much extra work for the chippers.

But to return to our reminiscences, as I before mentioned, the foreman was a good mechanic, and in spite of his little peculiarities knew his business thoroughly. One could tell at a glance that the shop was a well regulated one. Everything was neat and trim, and in its place. The floor was clean, and the flasks neatly piled. Every bit of scrap was carefully looked after. Each molder had an old crucible standing by his bench into which he threw the riddlings left in the seive after screening the sand onto the patterns. At the end of the week these riddlings were sifted to separate the sand from the scrap, which was washed and cleaned of nails with a magnet, to make it ready for melting. The ashes from the furnaces were saved, and about once a week taken to what might be called the salvage department, where the brass was extracted. The dry process of extraction was used, the ashes being ground to powder in a pug mill, and then screened. The amount of metal thus recovered would be a surprise to the uninitiated. Much of it had the appearance of shot. When returned to the foundry it was cleaned with magnets, then run into ingots and mixed with the new metal.

A NEW SHOP SYSTEM.—4.

DEALING WITH THE ORDERS FROM THE SHOP, THE COST OF LABOR AND MATERIALS, THE DISTRIBUTION OF PLANT CHARGES, THE COST KEEPING, ETC., AS CREATED TO MEET THE REQUIREMENTS OF A PLANT DEVOTED TO THE MANUFACTURE AND SALE OF MACHINE TOOLS.

GEO. D. CHAPMAN.

Delivery Sheet.

The Delivery Sheet is of the same form for all departments and has two sides, one for what are known as Top Works or parts of Tools, and the other for completed Tools. The size of the sheet is such that it is convenient both for the office and the salesmen.

Each side is so divided into columns headed On hand, Completed and Started in Works as to give a good and quickly accessible inventory of the stock at all times.

Machinery Order, or by Shop Order, except in the Drafting and Pattern Departments, where the written orders take another, as described in the writer's former article in MACHINERY, March, 1898.

When ordering special attachments, etc., where there are no Lists, the Shop Order is written in the regular manner as described in the engineering department rules, but at the bottom after the L is written Trip for the Casting list Number and L-667 for the Steel list Number.

9

The Trip means that the castings are listed and specified only upon the Triplicate Order, this Triplicate Order is used in checking, giving weights, etc., in the same manner as a Casting List, in other words in this case the Triplicate Order contains the Casting List.

L-667.

The 9 is the Steel List for, according to the system all

3-18-'98. FITCHBURG MACHINE WORKS. L-529

DISTRIBUTION OF PLANT CHARGES.

	MAIN ACCOUNTS.	SUB-ACCOUNTS.
NEW ASSETS.	A. STANDARD DRAWINGS	All labor designing and drawing on new machinery. † Each machine charge to separate account. Special outside jobs charge to "S. O. J."
	B. STANDARD PATTERNS	All labor, materials and bills on new machinery. † Each machine charge to separate account. Special outside jobs charge to "S. O. J."
	C. STANDARD JIGS AND TOOLS	All labor, materials and bills on new machinery. † Each machine charge to separate account. General jobs charge to general account.
	D. STANDARD MACHINERY	All labor, material and bills on salable machinery. † Each machine charge to separate account. (Above account sub-divide into "Piece No. Accounts.") General jobs charge to "general" account. Special outside jobs charge to "S. O. J."
	E. OFFICE AND SHOP FIXTURES	Salable furniture, shafting, pulleys, instruments, etc., charge to "general" account.
SELLING EXPENSE.	H. TRAVELLING EXPENSES	All labor and bills, travelling for sales, charge to "general" account.
	I. OFFICE EXPENSES	Officers' salaries, clerks and other office labor and supplies, charge to "general" account.
	J. ADVERTISING EXPENSES	All labor, material and bills for catalogues and other publications, charge to "general" account.
	K. INTEREST AND DISCOUNTS	Charge to "general" account.
	L. RECLAMATIONS	All deductions in settlement of accounts, including bad debts, charge to "general" account.
	M. FREIGHT AND CARTAGE	Expressage, handling, etc., not chargeable to other accounts, charge to "general" accounts. † Labor, materials and bills on boxing machinery. † Each machine charge to "separate" account. General jobs charge to "general" account.
MANUFACTURING EXPENSE.	O. DRAWING SUPPLIES	Paper, ink and other perishable supplies, charge to "general" account.
	P. SHOP SUPPLIES	Oil, waste, emery cloth, paint, nails and other perishable supplies, charge to "general" account. Belting, charge to "belting" account.
	Q. PERISHABLE TOOLS	All labor, materials and bills on drills, reamers, arbors, cutters, taps, oil cans and other perishable tools, charge to "general" account. Files, charge to "file" account.
	R. MAINTENANCE OF TOOLS	All labor, materials and bills on repairs of non-perishable and perishable drawings, patterns, jigs and tools and machinery. † Each machine charge to separate account. Repairs on belting, shafting and all other things, charge to "general" account.
	S. NON-PRODUCTIVE LABOR	Foremen, blueprinting, stock ordering and checking, helping, moving and setting up machinery, making lists, etc., charge to "general" account. † Each machine charge to "separate" account. General jobs charge to "general" account. Cost keeping, charge to "cost keeping" account.
	T. RENT, TAXES AND INSURANCE	Charge to "general" account.
	U. POWER, LIGHT AND HEAT	All labor, materials and bills, charge to "general" account. Coal, charge to "coal" account.
	V. INTEREST AND DETERIORATION	Interest and deterioration on "A," "B," "C," "D," and "E," charge to "general" account.
	W. PATENTS AND ROYALTIES	Charge to "general" account

† See Bureau of Information for Class of account for "each machine."

FIG. 15. DISTRIBUTION OF PLANT CHARGES.
(This is a blue print of a list. Size 10 in. x 13⅜ in.)

Having now given the pictures and names of the different men in this game of chess, we will take up their moves and describe the plan by which victory can be won.

The rules have been systematized under two main heads, i. e. those for the office and those for the engineering department. These have been indexed, paged and bound together, each page having a tab for quick reference. The rules for the New Machinery Orders have been printed upon brown paper, and those referring to the Shop Orders upon white paper, to further facilitate the handling.

The pictures, as given, have been filled in as in actual use and together with the accompanying Rules, will explain the system used.

The Rules are so sub-divided as to give only such rules on a page as refer to the conditions in hand and the index on the outside gives readily the page required when the subject is presented. (For lack of space these rules are omitted.)

All work in the shop is done by written orders, i. e., by New orders for steel pieces are given on blue print Steel Lists, in fact the blue print Steel List is the order for steel pieces. In this case L-667 is a Steel List, the same in form as the Steel List L-334 on page 276, made blank in regard to title and specification of pieces. The pieces wanted are written in black ink upon a blue print of this Steel List, which then forms an order for the steel pieces wanted; the sub 9 simply designates this order from the one which would follow it and which would be numbered sub 10, etc.

By this system the work in progress in the shop is readily shown upon the Shop Order stock in progress file, which is always at hand. This file is indexed by tabbed guide sheets, which show the Classes of Tools which have parts in progress in the shop, the tabs bearing Class insignia, as 13L, etc.

Only such tabbed guide sheets are exposed upon the file as represent work in progress at the time; so that without looking at the Shop Orders there filed, a general idea of what is being built can be told at a glance. Hurry up slips are inserted

wherever there is a particular rush for the parts. By consulting the Shop Order it can be ascertained what rough stock has been received and other details.

The New Machinery Order file quickly gives the tools ordered and sold, together with Date of Shipment Promised, etc., and keeps this subject well in hand. This file also gives the New Machinery Orders for Tools ordered for stock, and the stock New Machinery Orders are provided with tabbed guide sheets the same as the ones for the Shop Orders above described, and serve the same purposes as above.

As a guide to the Class of business being done the Tool Sold card gives a good index.

As it is often important to quickly tell what has been sold a certain party, the Trade Sold cards are of value.

PLANT CHARGES.

Their origin, their distribution, their determination, their keeping and their commercial value.

Every successful Manufacturing Plant to-day has its Cost keeping and Expense system, for each must determine its own expense charges, and must not take those of its neighbor.

Mr. A., the manager of a manufacturing plant, being asked how he determined his selling price made the following reply: "Why, I add 20 per cent. for expense charges, to the labor account and to that add the cost of the stock, and there you have the selling price." "How did you determine the percent for expense charges?" was next asked. "Oh, I took that from So & So, they ought to know for they have been in business over sixty years." So & So's business was in an entirely different line from Mr. A's, but that he did not consider, besides So & So had carefully figured their percent for expense charges and had found that 20 per cent. was enough to give them a profit. If Mr. A had had the same good judgment and had systematically figured the per cent for expense charges for his own plant, he would have found 50 per cent. nearer correct and at the end of the year selling at prices figured upon this basis would have had a profit instead of a loss for his reward, a successful instead of a depreciating business. Besides his ignorance in this matter led him to sell at such a low price that it injured his competitors and the trade in general. He is now poorer but wiser.

The Origin.

The Origin of Plant Charges may be said to exist in the two elements here named, i. e., active or labor charges, and inactive or material and bill charges.

The Distribution.

The Plant Charges are distributed into New Assets and Expense accounts; the Expense account is divided into Selling Expense and Manufacturing Expense accounts.

These three accounts are sub-divided into several Main Accounts, which are known by letters, for the sake of simplicity, these letter accounts are sub-divided into a large number of Sub-accounts, believing that a system with a multiplicity of accounts is productive of better commercial results than one with a few accounts; for with a large number of accounts it is settled at the beginning just were each item is to be charged, and besides with a large number of Sub-accounts the "leakage" can be more quickly located.

Above is given the Distribution of Plant Charges with the sub-divisions and the Sub-accounts to which the items are to be charged.

The Determination of Labor Charges.

It will here be necessary to introduce the source of the Labor Charges, i. e., the Daily Time Slip.

These slips are bound in blocks, 100 in a block, and upon the cardboard back of the block are printed the directions for charging the time, etc. Each man is furnished with a block and to it is attached a pencil with a rubber in the end.

All work is done from drawings, blue prints being used, or from sketches (The "sketches" are fully described in Machinery, March, 1898), and each piece upon said drawings for sketches has its Piece Number in a ⅝ in. circle so that with the directions upon the back of the Daily Time Slip block and the Notice, which is upon each drawing (For method of printing this Notice upon the blue print see Machinery, March, 1898.) and which reads, "On Daily Time Slip you must charge Time to marks in circle. You must state total Number of Pieces in lot" there is but little chance for errors.

This system, together with putting the Piece numbers in a circle has greatly strengthened what has been the weakest link in most chains by which the labor charges are determined, and it has been a vital point in the success of the writer's system.

As the Pay Roll is made out from the total hours set down by the men upon their Daily Time Slips the gross items must be correct.

These slips are carefully checked each day by the foremen and also the Cost Clerk to insure the correctness of the sub-entries, which gives very satisfactory results.

From these Daily Time Slips the items, for labor charges are entered upon the Cost Sheets at the proper time.

DAILY TIME SLIP. **29**

FITCHBURG, 11-25-1898.

Piece or Job Number.	Operation.	Lot of	Hours.
13 L 0074	Threading.	60	3½
13 L 69	Drilling.	60	6½
.....	.....	.....	10
.....	.....	.....	.....
.....	.....	.....	.....

FIG. 16. DAILY TIME SLIP.
Size 3 in. x 5 in. Color, brown. (This slip was filled in by man No. 29.)

Name, F. Brown. No. 29.

Fitchburg, 9-13-'98.

READ CAREFULLY.

Every workman must fill out a slip from his block, giving full time worked each day.

He must charge same in hours and fractions thereof to Piece or Job Numbers.

He must describe work as planing, turning, assembling drilling, etc., in "operation" column.

He must state how many pieces there are in the lot, in "lot of" column.

This slip to be deposited in the box EVERY NIGHT, and no time will be allowed except as shown by this slip.

FIG. 17. BACK OF DAILY TIME SLIP BLOCK.

Material and Bill Charges.

These are determined from the books kept in the office, which have the Main Accounts, or letter accounts shown upon the Lists of Distribution of Plant Charges above, also, the following Sub-accounts kept under their proper Main Accounts, i. e., sub-accounts for Belt, Files and Coal.

The Keeping of Labor Charges.

All Labor Charges are kept upon Cost Sheets. The Cost Sheet for Piece No. 13L, lot of 60 is here shown, this sheet is filed as specified upon the bottom of the Shop Order. File on 13L-Pc. No.-D Lot of 60.

The light vertical lines in the various columns on the Cost Sheet are of importance as a help to accuracy.

The arch file boards, upon which the Cost Sheets in use are kept, are hung in rows over the desk of the Cost Clerk, eighteen file boards only are used in this case. Each file board has a leather board cover which protects the Cost Sheets thereon.

Above each file board is a blue print label, which designates the contents of the file; in the case in hand the label reads D-13L, Lot of 60.

In describing the work which the Cost Clerk must do it will be necessary to refer to the Casting, Steel and Miscellaneous lists and the New Machinery Order, which we will call N. M. O., also the Shop Order, which we will designate by S. O., previously explained in this article.

When a N. M. O. or a S. O. is issued a copy is always given to the "Cost Clerk" see the Eng. Dept. Rules previously given, he at that time and before he delivers the orders makes out the Cost Sheets required, he also makes a note of the order upon the top sheet upon the proper file. N.M.O's. are noted in the upper right hand corner of said top sheet and S.O's. in the upper left hand corner.

Each N.M.O. only requires one Cost Sheet and that one is for the labor charges for assembling, as the N.M.O. only calls for assembling; all the Parts wanted being ordered upon S.O's.

The cost sheet for the N.M.O. in hand is filled in with black ink as follows, i. e., at the bottom of the sheet Lot of 1. Name

14 x 6 L Gem. Class 13L. No. Ass. Charge D. At the top of the sheet in the right hand corner is marked N.M.O.1.

Should there be other N.M.O.s the cost of which is to be kept upon this same sheet, then the Lot Of is added to for each N.M. O., and the entry in the upper right hand corner is increased also by one for each additional N.M.O.

At the bottom of the N.M.O. is marked File on 13L-Pc. No.-D Lot of 60, therefore this sheet is put upon the file board corresponding and proceeds, or is on top of, all the other sheets upon said file board; here the sheet receives the entries for labor charges and awaits the return of the N.M.O. marked completed.

FITCHBURG MACHINE WORKS.
COST SHEET.

DATE	NO. MAN	LABOR HOURS	LABOR COST	DATE	NO. MAN	LABOR HOURS	LABOR COST	DATE	NO. MAN	LABOR HOURS	LABOR COST
1898 10-19	13	7 5 0	1 1 2 6	11-5	76	9 0 0	2 7 0 0	11-23	76	1 0 0 0	3 0 0 0
"	15	1 0	1 5	7	35	1 0	2 5	25	29	6 5	1 6 2 5
"	22	8 5	1 2 7 5	"	76	1 0	3	"	76	1 0	3
20	13	1 0	1 5	8	35	1 0	2 5	26	29	9	2 2 5
"	15	1 0	1 5	"	76	1 0	3	"	76	9	2 7
"	22	5 5	9 2 5	9	35	1 0	2 5				5 8 5 2 5
21	13	9	1 3 5	"	76	1 0	3	28	29	1 0	2 5
"	15	1 0	1 5	10	35	1 0	2 5	"	76	1 0	3
"	22	8 5	1 2 7 5	"	76	1 0	3	29	29	1 0	2 5
"	35	7	1 7 5	11	35	1 0	2 5	"	76	4 2 5	1 2 7 5
22	15	9	1 3 5	"	76	1 0	3	30	29	1 0	2 5
"	22	6 2 5	9 3 9	12	35	9	2 2 5				1 2 8 2 5
"	35	9	2 2 5	"	76	9	2 7	12-1	29	3	7 5
24	15	7 7 5	1 1 6 2				5 8 5 2 5	"	87	9	2 4 7 5
"	35	1 0	2 5	14	35	1 0	2 5	2	87	1 0	2 7 5
25	35	1 0	2 5	"	76	1 0	3				1 7 5 0
26	35	1 0	2 5	15	35	1 0	2 5	12-14	87	1 0	2 7 5
27	35	1 0	2 5	"	76	1 0	3	15	52	1 0	2 6 5
28	35	1 0	2 5	16	35	1 0	2 5	"	87	1 0	2 7 5
29	35	9	2 2 5	"	76	1 0	3	16	52	5	1 3 2 5
			3 4 0 5 0	17	35	1 0	2 5	"	87	2	5 5
31	35	1 0	2 5	"	76	1 0	3				1 0 0 2 5
			9 6 5 5 0	18	35	1 0	2 5	12-21	52	1 0	2 6 5
11-1	35	1 0	2 5	"	76	1 0	3	"	87	1 0	2 7 5
2	35	1 0	2 5	19	8	9	2 2 5	28	52	1 0	2 6 5
"	76	8 7 5	2 6 2 5	"	76	9	2 7	"	87	1 0	2 7 5
3	35	1 0	2 5	21	8	1 0	2 5	29	87	1 0	2 7 5
"	76	1 0	3	"	76	1 0	3	30	87	8 2 5	2 1 6 9
4	35	1 0	2 5	22	8	1 0	2 5				1 5 7 1 9
"	76	1 0	3	"	76	1 0	3				3 1 7 1 9
5	35	9	2 2 5	23	29	1 0	2 5				
COLUMNS	264	7 5 5	7 4 2 5	COLUMNS	765	1 0 0	8 1 0 0	COLUMNS	765	1 0	6 0 6 9
BR'T FOR.				BR'T FOR.	264	7 5	7 4 2 5	BR'T FOR.	539	7 5	3 0 5 2 5
TOTALS				TOTALS	539	7 5	3 0 5 2 5	TOTALS	765	1 5	3 4 5 9 4

STARTED 10-19-'98	STOCK DATE 10-18-'98	HRS. EA. PC. 12.76
LOT OF 60	NO. MAN ——	AV. WAGE .254
COMPLETED Jan. '99	KIND C1	LABOR EA. PC. 3.24
	WEIGHT 69	STOCK EA. PC. 1.70
	PRICE .025	LABOR & STOCK 4.94
	TOTAL 1.70	EXPENSE 2.92
		TOTAL 7.86

NAME Carriage
CLASS 13L NO. 13L 69 CHARGE D

L-487

FIG. 18. COST SHEET.
Size 6¼ in. x 10 in. Color, brown. (All filled in and figured for Piece No. 13L 69, Lot of 60, charged to D-13 L, Main Account.)

Each S.O. issued requires sundry Cost Sheet if the piece cost is to be kept, which is the case with all standard Tools, and the note upon the S.O. calls attention to this fact, it reads "Charge all time on Daily Time Slips to Piece Numbers." If, however, for some reason, the time is to be kept in bulk, then the "Piece Numbers" is crossed off and the Job Number is given in a circle as (R 48 L) the note then reads, Charge all time on Daily Time Slips to (R 48 L)

In this case only one Cost Sheet would be required which would read at the bottom as follows, in black ink, i.e., Lot of 1: Name Repairs. Class 48L. No. ——. Charge R. In the upper left hand corner of the sheet would be written S.O. L.

This Lot Of and S.O. would be added to if other S.O's. were issued which were chargeable to the same Job Number, i. e., (R 48 L)

In the case of a S.O. which reads Charge all time on Daily Time Slips to Piece Numbers a Cost Sheet is required for each Piece called for on the blue print piece order lists specified at the bottom of the S.O.

In the case which is here shown the S.O. called for 60 Compound Carriages and gave the lists as L-332, 334; therefore, a Cost Sheet is required for each piece specified upon these blue print piece order lists, and these Cost Sheets are made out before the Cost Clerk delivers the S.O.

The Cost Sheet shown is for one of these pieces, i. e. 13L-69 and is filled in at the bottom of the sheet with black ink as follows, i. e., Lot of 60. Name Carriage. Class 13L. No. 13L 69. Charge D.

This sheet with the others made from the above lists, is filed numerically upon the file board for D-13L Lot of 60 as called for at the bottom of the S.O.

The sheets are filed numerically by Piece Numbers, i. e., the casting numbers 1, 2, 3, etc., first, then the steel numbers 001, 002, 003, etc., and lastly, the miscellaneous numbers 01, 02, 03, etc. (For system of Piece Numbers see Machinery, March, 1898.)

In the upper left hand corner of the top sheet upon this file board, presumably the assembly sheet is entered this S.O. as S.O.1.; and to this is added 1 for each other S.O., the Cost Sheets for which are filed upon this file board.

The Entering of Labor Charges.

The labor charges are entered with pencil upon these Cost Sheets and the items are taken from the Daily Time Slips. If in any case more than one Cost Sheet is required of any one Piece Number the lower right hand corner is cut off on all sheets of that Number except the last one.

Take the Daily Time Slip here shown for man No. 29; the item charged to 13L is entered upon this "Cost Sheet" as follows, i. e. In the "Date" column 11-25, the date of the time slip; In Number, Man 29; in Hours, 6.5, and the Cost is carried forward later.

In this case the Pay Roll is made up once in two weeks, so the items for labor charges are only entered from the Daily Time Slips and the Cost carried forward when the Pay Roll is completed, or once in two weeks.

When the Labor Charges are being entered upon the Cost Sheets each day's Daily Time Slips are counted separately and the total number of men at work is entered upon a calendar under that date, also the hours the shop has run. The purpose of these entries will later be explained.

An Hourly Wage list is provided, which gives numerically the Number of each man and opposite each Number the hourly wage paid said man.

Pay Roll Trial Balance.

A Pay Roll Trial Balance is drawn off from these Cost Sheets once in two weeks which must of course check approximately with the corresponding pay roll. From each Cost Sheet is drawn off the Cost which applies to this Trial Balance.

Referring to the Cost Sheet shown, the Cost which applied to the Pay Roll Trial Balance for dates 10-19-'98 to 10-29-'98 inc. was $34.050; this is written in black ink. The Costs which applied to the other Trial Balances were $58.525, $58.525, $17.750, $10.025 and $15.719.

The Pay Roll Trial Balance is reported in black ink upon a slip as shown below and all the slips which refer to any one month are pasted to the back of a blank cost sheet and this sheet is filed with the Cost Sheet for that month. This is done to readily show that the Labor Charges for that month have been checked.

Pay Roll Trial Balance.
10-16-'98 to 10-29-'98 inc.

Pay Roll	$5260.84
Cost Sheets	5260.25
Short	.59

PAY ROLL TRIAL BALANCE REPORT.
Size 2 in x 5 in.

If Short the entry is made in black ink.
If Long, the entry is made in red ink.

A slight discrepancy may be expected as the Costs are only carried to the mills, which for the decimal of an hour may give a slightly short or long entry, these discrepancies in two weeks will amount to several cents at least.

Monthly Report.

The Monthly Report Sheet is made to cover three months, and is made to show the total Labor Charges and Bill Charges against each of the Main or letter accounts, described upon the Distribution of Plant Charges. The Labor Charges are divided into the Sub-accounts there specified, but the Bill Charges only have a few Sub-accounts as mentioned above. [On account of the size the monthly report sheet is not reproduced.]

MONTHLY REPORT SHEET.
Size 30 in. x 20 in.

To obtain the monthly Labor Charges each Cost Sheet is inspected and the Cost which applies to the month in hand is entered under its proper Sub Accounts. When all the Labor Charges are drawn off the items entered under each Sub Account are added together and the total charges are entered under their proper Sub-accounts upon the Monthly Report Sheet.

The Labor Charges are drawn off from the Cost Sheets in red ink upon Trial Balance sheets, and from these upon the Monthly Report Sheet. These trial balance sheets are filed with the Cost Sheets for the given month, as a matter of reference.

Upon each Cost Sheet the monthly Cost is entered with red ink, to distinguish it from the Pay Roll cost. Upon the sheet here shown the monthly Cost for Oct., was $36.550; for Nov., $128.825, and for Dec., $31.719.

The Monthly Report Sheet is not drawn off until all of the Pay Roll Trial Balances included in said month have been made out.

The figuring of the black ink total Costs for the Pay Roll Trial Balance and the red ink total Costs for the Monthly Report, saves much adding when the time comes for figuring the Cost Sheets in order to make a report upon the Piece or Job costs.

The Bill Charges are entered under their proper Sub-accounts and then the Monthly Report Sheet is ready for the figuring.

All of the entries in the first and third months specified upon the Monthly Report Sheet are made with black ink; but, those for the second month are made with red ink, this adds clearness and saves time.

* * *

THE COMMERCIAL ADVANTAGE OF THE OIL ENGINE.

JOHN A. SECOR.

The supreme importance of low cost power in all manufacturing industries is now universally conceded, and it is also known—at least to those familiar with engineering progress—that the internal combustion heat engine is far superior in economy of fuel, or efficiency, to the steam engine. In fact, it is now known that the principle of internal combustion represents the highest obtainable efficiency in a heat engine.

When we bring the steam engine to account, and compare carefully its consumption of fuel with the work done by it, we find that there is enormous waste. Thus a consumption of 1 1-2 pound of coal per hour per horse-power is regarded as an exceedingly good performance in a steam engine, yet it means a utilization of only about 12 per cent. of the total quantity of heat generated by the burning of coal; and with 6 pounds of coal per hour per horse-power (which is not uncommonly thought to be economical) there is only a utilization of about 3 per cent. of the total heat energy.

The best steam engines are very nearly as economical as any heat engine can be with the limits of temperature at which they receive and reject the steam. In the design and construction there is no great room for improvement. As an engine, the steam engine is nearly perfect, but so much the worse for the steam engine. Its possibilities are limited by the fact that in any heat engine the amount of heat transformed into mechanical power depends on the limits of temperature between which the engine works.

A good gas engine of medium size uses less than one pound of coal converted into gas per H.P. every hour. Expressed in per centage of efficiency, the very smallest gas engine has the efficiency of the largest triple expansion steam engine, and this efficiency increases with the size of the engine until we reach 25 per cent. in the case of ordinary sizes, and when we come to the larger sizes, the well-known authority, Mr. Dugald Clerk, in his work on "Gas and Oil Engines," page 386, states: "In the author's opinion efficiencies of 45 per cent. of the whole heat given to the engine are now within reach of the engineer."

The internal combustion engine has the important advantage over the steam engine of requiring less attention, and occupying less space. It is not surprising, therefore, that internal combustion motors (using artificial or natural gas or gasoline as a fuel) are now rapidly coming into general use.

Some recent installations of power plants will illustrate this. A contract was recently awarded by the main drainage committee of the London City Council for eight gas engines, four of them to be double cylinder engines of 210 indicated H.P. each, and four of 250 H.P., the whole aggregating over 1,800 H.P. The automobile factory of De Dion and Bouton, on the Quai de Seine, Paris, is now being equipped with a 600 H.P. Crossley gas engine. As another significant illustration, the town of Gibsonburg, Ohio, recently paid $1,000 more for a gasoline pumping plant than the cost of a steam plant of equal capacity, and as still another, there are over 50,000 gas engines of one make—the Otto—now in use.

In order to popularize the internal combustion motor and obtain a wider market for gas production the Brookline Gaslight Co., of the City of Boston, is proposing during the present year to furnish gas for engines above 200 H.P. at one cent per H.P. per hour. The price ordinarily charged for illuminating gas in our large cities, however, precludes its use as a fuel for the production of power in large installations. Gasoline has been used to a limited extent as a substitute for gas, but although far more dangerous to handle, it is only slightly cheaper than illuminating gas. Where illuminating gas costs $1.15 per thousand cubic feet, it represents about 2 cents per H.P. per hour; with gasoline at fifteen cents per gallon the cost is about 1 1-2 cents per H.P. per hour.

The great success already achieved by the gas engine, would have been far greater, if a satisfactory fuel were available. Illuminating gas is obtainable only in the gas house area, beside being too costly for use in large engines. Naphtha is only slightly cheaper than gas, and is too dangerous for general use. Having these considerations in view, numerous attempts have been made to use kerosene as a fuel in internal combustion motors.

MINERAL OIL—AN IDEAL FUEL.

Kerosene, or mineral oil, meets every requirement for a fuel suitable for producing low cost power for general use, inasmuch as it combines the absolutely essential elements of safety and low cost, besides being universally obtainable in all lands. It is the most highly concentrated form of fuel known. Considered scientifically, it is solar energy condensed into a safe liquid gas.

Its Thermodynamic Value.

The following table will show its vast superiority over other well-known forms of stored energy.

Dynamic value of unit of weight of various sources of power:

Source of Power.	Pounds. Foot	Medium Weight of
A good battery will store	15,000	per lb. battery.
Liquefied air expended from 2,000 lbs. down to atmosphere under ideal conditions would develop...	139,100	per lb. air.
Coal of 14,000 B. T. U. used in a steam engine plant of 12½ per cent efficiency would yield.....	1,408,000	per lb. coal.
Petroleum oil of 20,700 B. T. U. consumed in an explosion engine of 35 per cent. efficiency would yield	5,503,000	per lb. oil.

Thus it will be seen that one pound of petroleum or refined kerosene oil used to produce power in an internal combustion oil engine develops far more mechanical energy than an equal weight of any other medium either for producing or storing power. It requires 50 pounds of liquefied air or 400 pounds of storage battery to equal the power obtainable from one pound of kerosene oil costing about one cent. As a reservoir of power, one gallon of oil is superior to one ton of storage battery. If air could be compressed to liquefaction and supplied gratuitously to consumers the extra cost of storage and transportation would render it inferior in economy to commercial mineral oil.

Its Falling Price.

The average export value of refined illuminating oil was, in 1888, 7.9 cents per gallon, and in 1898, 5.2 cents per gallon; hav-

ing fallen from 24.9 cents in 1872 to 5.2 in 1898. Notwithstanding this great fall in price, the production and exportation continued to increase, the exports having increased over 60,000,000 gallons in the past year over that of the preceding year, and over 100,000,000 gallons above any previous year. Foreign countries are now paying over a million dollars per week for American oil.

The Difficulty of Utilizing Oil for Power.

Although the great advantage in economy which an oil engine would have over any other form of heat engine, has been well understood for several years, it has been found impracticable to produce a satisfactory oil engine, until very recently. The difficulties which have prevented the oil engine hitherto from superseding not only the gas engine, but the steam engine as well, have been the very serious difficulties of excessive vibration, unreliability, and above all, the train of evils resulting from the absolute impossibility of obtaining perfect combustion.

The production of a commercial oil engine, suitable for large plants depends on the solution of inter-related problems in chemistry, thermodynamics and mechanics, but the engineer is seldom a chemical expert. It is not overstating the case to say, that the chemical problem of perfect combustion under varying conditions has been practically ignored.

Speaking generally, previous attempts to adapt the gas engine to the use of oil, have consisted in devising suitable pumps for supplying the oil together with various forms of vaporizers for its gasification. The various "oil engines" have been simply gas engines with a pump and vaporizer added but without exception the result has been unsatisfactory.

Essential Features of an Oil Motor.

The main features required in a satisfactory oil engine may be readily grasped, even by those who are not engineers. It is important that an oil engine should be easy to start, so that any one of ordinary intelligence can start it without requiring special starting apparatus. It is important that an oil engine should be capable of continuous and reliable service that even a layman can understand. Any engine that is in the habit of stopping unaccountably after two or three days running would not be satisfactory to the user.

The ordinary user of an oil engine is capable of determining when an engine is running smoothly, and it does not require an engineer to decide which is preferable, the engine which is subject to vibration, or the one which is entirely free from shock. The ordinary business man can appreciate that enormous weight in any engine in proportion to power developed might possibly detract from the commercial value of an engine, not to mention first cost.

When engineers, engineering text books and periodicals state that the great desideratum in an oil engine is perfect combustion, inasmuch as a smoky exhaust indicates indisputably, that two serious faults exist in such an engine, one being the unavoidable and constant fouling of the interior mechanism from unconsumed carbon, and the other fuel waste, the truth of such a statement is self-evident. It is equally evident, that if two or three oil engines are run in competition, and one has a clean exhaust, while the others are smoky, that no elaborate engineering test is required to determine with certainty which is producing the most power for a given consumption of fuel. In a word, it is far easier for a layman to form a correct judgment in regard to an oil engine, than it would be in the case of a steam plant, even in the simplest installation.

The unparalleled commercial opportunity offered to any feasible system of cheap power production, led to the exhaustive series of chemical and mechanical researches by the writer which culminated in the production of a new type of oil engine which has manifest advantages over other systems as is shown in the following table:

Electric Motor	3.6	cents per H. P. hour.
Gas Engine	2	" " " "
Gasoline Engine	1.5	" " " "
Stationary Steam Engine	1	cent " " "
Niagara Power	¾	" " " "
Secor Motor (using oil)	½	" " " "

The low cost of "Niagara Power" has had a remarkable effect in stimulating manufacturers within its power radius, yet it costs fifty per cent. more than power obtained by the best oil engine for motors delivering not less than fifty H.P.

Thus the best oil engine connected directly to a dynamo constitutes a complete electric plant, combining at once the maximum of economy and safety. The cost of ten sixteen candle-power incandescent lamps for one hour is one cent when kerosene is used. For larger plants using fuel oil, about one gallon per day per H.P. is required, costing about 2 1-2 or 3 cents. This is equivalent to 100 sixteen candle-power incandescent lamps per hour for (3) three cents. The combination of the oil engine with a dynamo will greatly reduce the present cost of electric lighting, as there will be a three-fold saving of expense, whether in small isolated installations, or in larger plants. First, in cost of plant delivered on ground; second, in cost of erection ready for use; third, in cost of operation.

The cheapest light now in use is furnished by the common kerosene lamp, but as a matter of fact, one gallon of commercial kerosene consumed in the oil engine will produce a greater quantity of light, than if the same oil were burned in lamps.

* * *

THE DESIGN OF WRENCHES.

Editor MACHINERY:

We have read with interest the article entitled, "Proportions for Wrenches," by Retsel, in your May issue, and venture to offer a further contribution to the discussion of that theme.

The best modern practice does not, we think, prefer wrenches with the openings in a straight line with the handle, as shown by the illustrations in the article named. On the contrary, a wrench with the opening at fifteen degrees angle with the handle is better because it, and it alone, will turn a hexagon nut completely around where the swing of the handle is limited to thirty degrees. All makers of standard forged wrenches now furnish them with the fifteen degree angle. We were, ourselves, the first to place a line of them upon the market.

Again, we do not think it the best practice to have the base of the opening made with flat sides corresponding with the faces of the nut. These flat sides perform no function in turning the nut, and the three angles formed at the base of the opening by the meeting of these three flat faces are excellent starting points for cracks. Furthermore, if the nut should be slightly small the wear upon it of these flat sides tends to round away its sharp corners. It is better designing, we venture to suggest, to make the base of the opening curved, doing away wholly with the central angle and practically removing the other two, while still leaving the sides of the opening full width to grasp and turn the nut; these two sides being the only portion which in either design so actually operate.

As a general rule, we have made the length of our wrenches fourteen times the diameter of the bolt; the thickness of the head, three-quarters the bolt diameter and the thickness of the handle one-half that of the head.

We are glad to concur with many of the suggestions found in the article cited. Wrenches should be made of forged steel throughout, rather than from wrought iron, and it is regular to provide a hole in the end of the handle of the largest sizes for use with tackle.

We cannot, however, concur with the statement that larger sized wrenches should not be case-hardened lest they be "too brittle" for the work they have to do. The result of the case hardening process is merely to create a thin, hard shell upon the surface of the wrench; the thickness of this shell is, say 1-100 inch to 1-32 inch, while the interior of the metal is unaffected and remains strong, tough and fibrous, as before. In short, we have yet to learn from an experience of over fifteen years in making wrenches, both case hardened and soft, that the case hardening of large wrenches renders them liable to breakage in the least degree; indeed, rather more care in this respect should be given the small sizes, where, unless caution is exercised, the case hardening may go clear through, with resultant brittleness.

WILLIAM C. REDFIELD,
of J. H. Williams & Co

Brooklyn, N. Y.

* * *

To compute the gear of a bicycle, multiply the diameter of the rear wheel in inches by the number of teeth in the forward sprocket and divide the product by the number of teeth in the rear sprocket. The quotient is equal to the diameter of a wheel that in one revolution will roll as far as one turn of the cranks will propel the geared machine. The computed gear multiplied by 3.1416 gives distance in inches traveled during one rotation of the cranks.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

A practical journal for Machinists and Engineers, and for all who are interested in Machinery.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

ONE DOLLAR A YEAR, POSTAGE PREPAID, TEN CENTS A COPY.
FOREIGN SUBSCRIPTIONS ONE DOLLAR AND FIFTY CENTS A YEAR.

Lester G. French, Editor.

Fred E. Rogers, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

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SWITZERLAND.—Zurich: Mayer & Zeller.
TURKEY.—Constantinople: V. L. Levy.

JUNE, 1899.

CIRCULATION STATEMENT.

The regular edition of MACHINERY for June is 17,750 copies. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. No papers are sent free except to advertisers and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

The IRON AGE, about	7,000
The AMERICAN MACHINIST, about	12,000
MACHINERY	17,750

INVENTIONS.

It is a curious but evident fact that a large proportion of the inventions that are granted protection each year by letters patent are the ideas of persons who have no direct connection with the business affected by their improved devices and who in many instances have no mechanical training whatever. To be sure, a large number of the patents ground out yearly by the government mill represent only a waste of time and money on the part of misguided inventors and are a standing reproach to a really beneficient system which has been too often prostituted to the benefit of some unscrupulous lawyers. A reputable attorney may, however, be obliged to put through that which he is convinced is a foolish scheme by the impetuosity of the inventor who will not listen to anything tending to discourage him in his undertaking. In such an instance the attorney can either push through the application or let the job go to some one else, but being only human he usually considers that the fee might as well be in his pocket as in that of another.

The point is, however, that many inventions made by men having no personal experience in that business and under circumstances that would seem to offer no inducement for thought along the lines of machine design (for any inventor must be to a certain extent a designer) are commercial successes. The men using the machines or processes which may be improved by the non-professional inventor would naturally be expected to know their faults and capabilities better than an outsider, but they are often the last ones to improve on a defective design or to see better methods for accomplishing the same result.

It is comparatively rare to find an ordinary machinist who is an inventor to the extent of protecting his ideas by patent as in the first place he does not have the time to think for himself and then again he is very likely to minify the importance of his own creations.

The successful inventor is usually something of an idler so far as having a fixed and regular occupation to take his time and thoughts. He is therefore something of a free lance, not hampered by the conditions of his business and is also usually free from the conservatism that is too often a bar to the exploration in a new field and which is so likely to hamper the efforts of a mechanic. To illustrate we might take the conception of the average person, who is entirely ignorant of shop practice, of the operation followed in turning a piece of metal in the engine lathe to a more or less complicated pattern, and it will usually be found that he will think of the operation as being simultaneous; that is, the piece as being operated on its whole length at the same time. The machinist knows by his experience that such a method is impracticable and would probably discourage any scheme that would involve that principle to cheapen production. But is such an idea impracticable? Evidently not when some of the forming lathes that are on the market are considered for here we have the exact conception of the non-professional which was proved impracticable in the past but which is now reduced to an everyday success. Again the finishing feeds of 6″ to 12″ wide taken on metal planers of modern design go far to fulfill the popular ideas of making plane surfaces. So it is that the progress of the different improved devices render schemes practicable that a few years ago would have been utterly impossible.

The only advice that can be given to the experimenter and inventor is to be practical and conservative, but not to be too conservative or too practical as conservatism comes from experience and the true inventor must always travel in unknown paths, to a certain extent, and discover means of making those things possible that past experience has to a great degree showed to be impracticable.

* * *

FIRE-PROOF CONSTRUCTION.

Some recently published statistics show that the fire loss in the United States for the first four months of the present year aggregated in round numbers the enormous sum of $50,000,000, while the secondary losses which can only be estimated would greatly swell the total figure.

The lamentable feature of this condition of affairs is that it is to a great degree preventable by what is known as fire proof construction, which simply means that materials are used in the buildings that are not combustible. While the greater part of this destruction probably did not affect manufacturing establishments the importance of having such buildings so constructed as to be proof against the destroying element cannot be over-estimated. No prosperous business can ever be compensated for its losses by a destructive fire from the amount paid by the insurance company. The destruction of patterns and drawings, the derangement of plans and the failures to fill important orders all make a serious fire a most dreaded visitation.

One of the leading tool builders of this country makes a strong point of the fact that the buildings being fire proof, customers need have no fear that important contracts will be delayed by the destruction of the plant. The importance of this risk is too often overlooked in the placing of contracts.

The owners of a shop built on fire proof lines can consistently, other things being equal, take contracts for the guaranteed delivery of machinery at a certain date when the contract carries with it the forfeiture of a bonus in case of failure, at a cheaper price than a shop built on the familiar tinder box plan. We say that they can consistently afford to take risks that the latter cannot because if the owners of a wooden shop do business on a business basis they must insure their buildings and machinery against loss by fire, but as they cannot usually insure against the possible loss from the inability to fulfill contracts they should set aside a certain sum each year as a sort of sinking fund to provide for such emergencies, which becomes a part of the cost price. It is perhaps needless to remark that this is seldom done, but the force of the argument will be recognized by shop owners.

RADIAL DRILLS OF MODERN DESIGN.

SOME CHARACTERISTICS OF THE MACHINES BUILT BY THE DIFFERENT MAKERS.

The radial drills which we illustrate in this number are typical machines representative of the best American practice. A study of the arrangement and design of these machines cannot fail to be profitable to any who are engaged in the construction of machinery or who are interested in machine tools.

There may be said to be two distinct types of radial drills, one of which is belt driven throughout and the other of which is gear driven. Both have their advantages and both give satisfaction to their users. The gear drive makes possible a decided reduction in the speed between the cone pulley and the drill spindle, thus making the machine very powerful for heavy work. The belt drive, on the other hand, avoids transmitting power around numerous corners, as must be done with the other style, by belting directly to the drill spindle, and gives a very steady motion particularly adapting the drill to boring. In this class, however, the reduction between the belt and spindle is sacrificed and to compensate for this the back gears are generally placed on the spindle so as to retain the high belt speed when drilling large holes.

Radial drills may also be said to be divided into classes relative to the arrangement of the arm. In one class, the arm is pivoted on a saddle which is arranged to slide on the column or upright. In the other class the arm slides upon the column itself and the arm and column revolve together. The former type is met with in the East more frequently than in the West, while the latter class is more distinctly a Western production.

Another noticeable thing in comparing the various designs is the fact that in the West the demand seems to be for machines which will start, stop, reverse and on which the back gears can be thrown in or out by the simple movement of a lever, while the machine is running. In the East the drills are generally provided with two pulleys on the countershaft, one of which is used for drilling and tapping and the other for backing out the tap, a friction tap-holder being used in the spindle.

Still another noticeable point in this connection is the largely increased use of radial drills for general machine work, both large and small. When Geo. H. Corliss fitted up his extensive works at Providence, R. I., he designed and built many special tools for the manufacture of his engines, among which were several radial drills. At that time a radial drill was a special tool and it did not have the quick return nor other features for rapid work that are now so common. These machines have been so greatly improved, however, that they are now used in preference to any other type for a great variety of work and they are an essential tool for most shops.

The descriptions which follow are based entirely upon the material which was furnished us by the different manufacturers, and the fact that some drills are described more fully than others should not be taken to mean that preference is given to any chosen few. It simply indicates that some manufacturers furnished more complete data than did others. Several manufacturers, also, for one reason or another, have not been able to send us photographs and descriptions in time for this article.

AURORA TOOL WORKS, AURORA, IND.

The Aurora Tool Works make radial drills in one size only—80-inch—which is illustrated in Fig. 1, page 308, their product being principally upright drills. The machine is modern in design and construction and is stiff and rigid. The cone pulley has four-inch face, is 16 inches in diameter and is geared to give one turn of the spindle to three of the cone, thus making a very powerful drive. The spindle is 1¾ inch in diameter. The column is of box section and the saddle, which is gibbed to it, is raised and lowered by power. The drill-head is moved along the arm by means of a crank at the end of the arm and a double-threaded screw. The arrangement of the drive and the feed mechanism are so clearly shown in the illustration that a further description will not be necessary.

BAUSH & HARRIS MACHINE TOOL CO,. SPRINGFIELD, MASS.

In the line of radial drills built by this company the attempt has been made not only to produce strong, well-built tools, but tools that could be operated quickly and conveniently by the workman. To this end the arm is supported by patented ball and roll bearings and in the feed mechanism, which is designed for either hand or power, the clutches are of the patented Baush "saw-tooth" design. Anyone who has run a power-feed drill press knows with what difficulty the clutch is thrown out when the feed is on, owing to the friction between the sides of the square clutch teeth. For releasing the feed, therefore, a friction clutch is usually provided which can be operated easily, but which has its disadvantages when the feed is heavy. The Baush clutch is positive and at the same time is as easily operated as the ordinary friction clutch. The teeth are ⅛" high and of saw-tooth shape and the two halves of the clutch are brought together or separated by a quick cam motion which holds the two halves positively in place. The teeth, being fine and pointed, readily mesh with one another, whatever the position of the respective parts at the instant when the cam is moved.

Besides the regular drill, which is practically a belt driven machine, the Baush Co. build many modifications and special designs, including geared, semi-geared and combination drills. Under the latter head is included the No. 12 design illustrated in Fig. 3, on page 308, which has a reversing motion on the cross-head by which it can be used for tapping without shifting the counter belts. With this arrangement the drill may be fed, reversed or stopped by the single lever on the cross head without stopping the machine. At the same time the drill is capable of exerting its full capacity for regular work. Another attachment which can be incorporated, if desired, is an automatic stop for the feed by which a series of holes may be drilled of the same depth.

In regard to the more general features of the machine, the manufacturers state that the driving power is limited, so to speak, only by the strength of the drill; the range of feeds is ample, and the back-gears are mounted directly on the cross-head, making possible a high speed of the driving mechanism up to the drill spindle itself.

THE BICKFORD RADIAL.

The full universal radial drill shown in Fig. 3 is one of a family of five sizes made by the Bickford Drill & Tool Co., Cincinnati, Ohio. It is a strong, well designed tool, possessing every feature requisite to modern practice.

The spindle has four changes of speed and three changes of feed, and is provided with both hand and power feed and quick advance and return, and will work at any angle within the circumference of a circle described by the point of the drill.

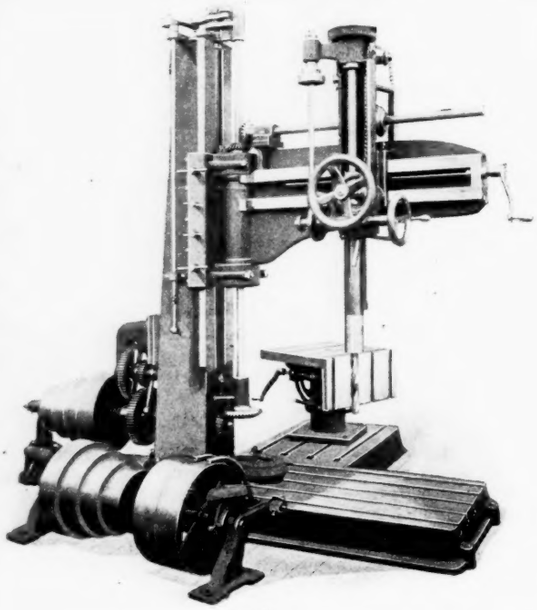
The saddle is operated by means of a screw, contains a locking device for clamping to arm and is graduated to 90 degrees either side of 0, making it easy to set the spindle in a moment to drill at any angle in a plane parallel with the guide-ways of the arm. A dowel pin locates the vertical position.

The arm is also made to swivel on its center, being operated by a worm and worm-wheel, which is graduated on its circumference. These graduations, together with the projections on the arm, enables the operator to set the machine in a few moments so as to drill at any angle radiating from the center of a sphere. The arm is raised and lowered by power by means of a simple mechanism placed within convenient reach of the operator, is easily swung round, and quickly clamped, although this last is unnecessary in drilling holes of small diameter.

The sleeve, or outer column, is mounted on a stationary stump which extends up, and is given a bearing near the top of the machine. This is equivalent to a double column, and affords a degree of stiffness not found in the tools of earlier design. The sleeve rests upon steel rollers interposed between it and the stump.

These machines are made in four styles: With plain head and plain arm, where vertical holes only are to be drilled; with tapping head and plain arm, where it is desired to tap by power; with swiveling head and plain arm, where a half universal radial will meet requirements; and with swiveling head and swiveling arm, where the nature of the work is such as to require the use of a full universal radial.

None of these need description, except the tapping head, which is an automatic device whereby the ordinary operations of tapping are greatly facilitated. The tap is started in the usual manner, by pressure against the work, and as soon as it has taken hold, the spindle is drawn down until an adjustable dog in



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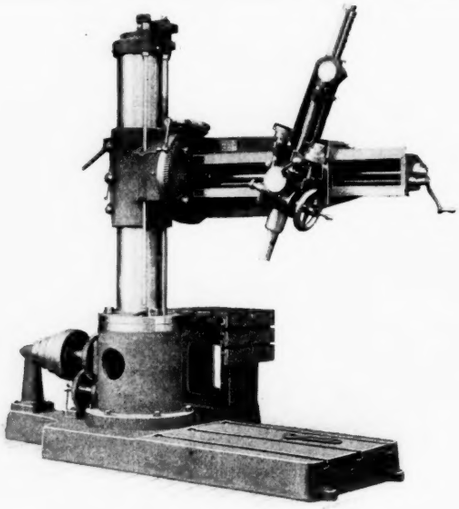

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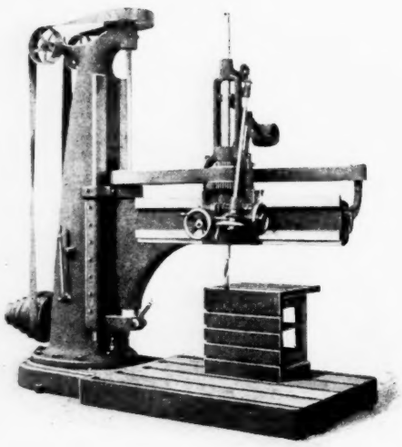

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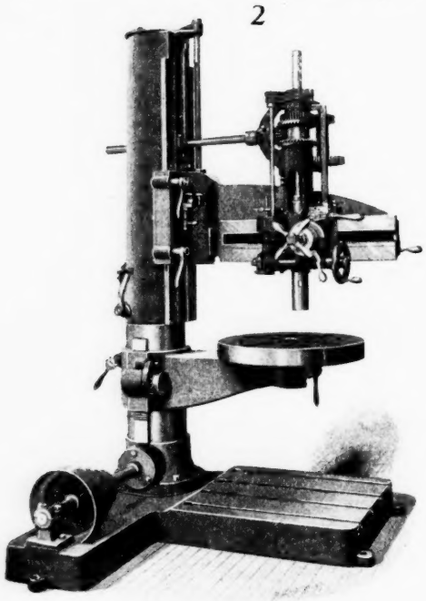

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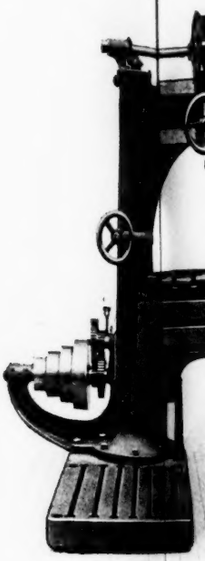

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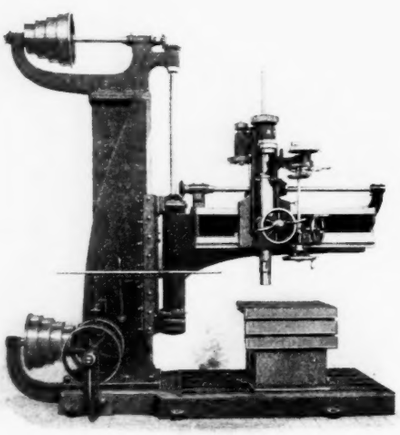

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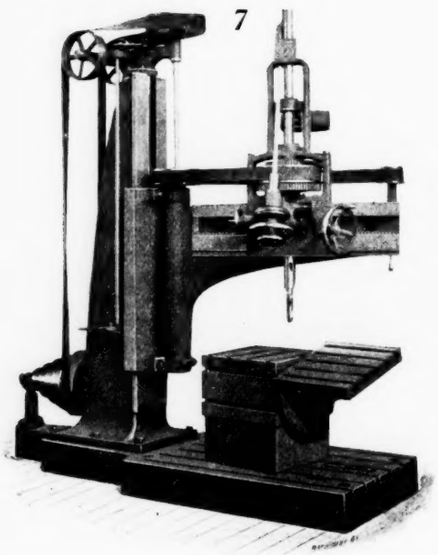

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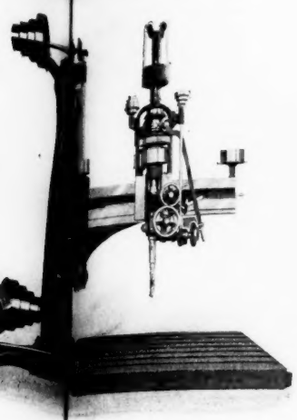
1.—Aurora Tool Works, Aurora, Ind.
2.—Bickford Drill & Tool Co., Cincinnati, O.
3.—Baush & Harris Machine Tool Co., Springfield, Mass.
4.—Cincinnati Radial Drill Co., Cincinnati, O.
5.—Dreses, Mueller & Co., Cincinnati, O.
6.—Fitchburg Machine Works, Fitchburg, Mass.
7.—Wm. E. Gang & Co., Cincinnati, O.

Some Types of Ra



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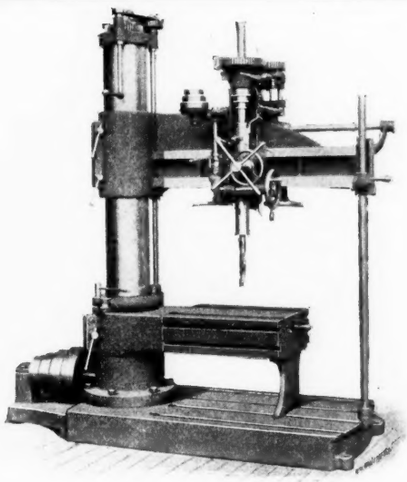

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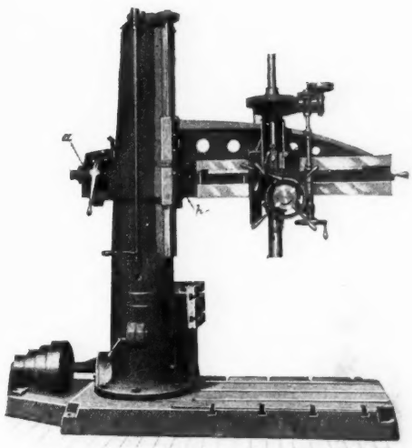

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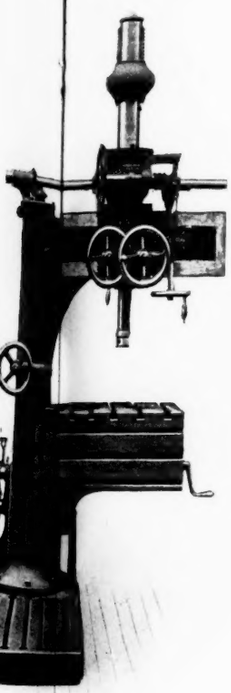

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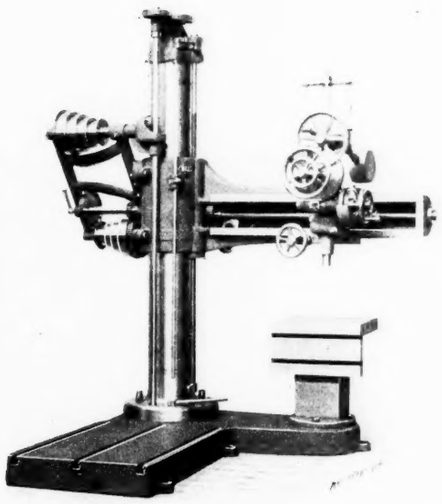

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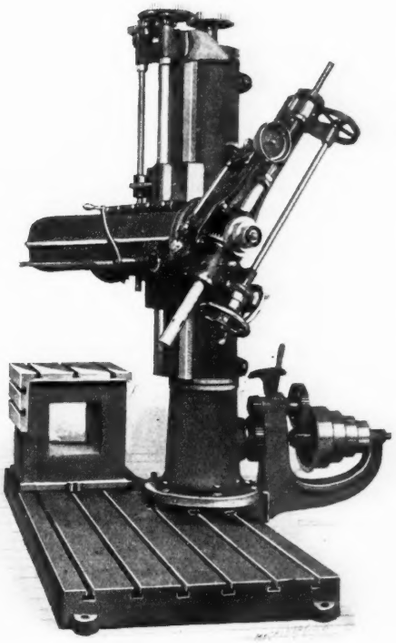

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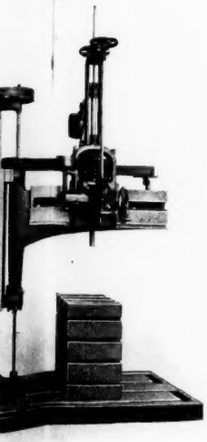

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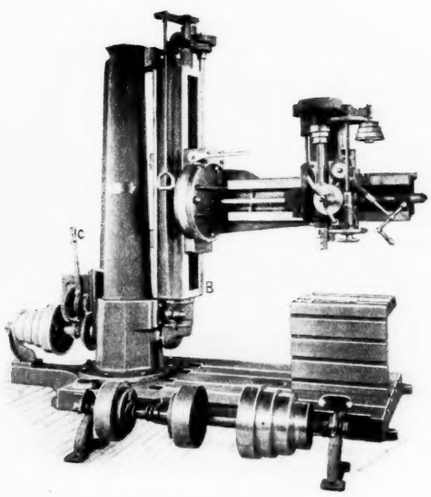

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es of Radial Drills.

8.—Edwin Harrington, Son & Co., Inc., Philadelphia, Pa.
9.—Niles Tool Works Co., Hamilton, O.
10-11.—Prentice Bros. Co., Worcester, Mass.
12.—Pond Machine Tool Co., Plainfield, N. J.
13.—Wm. Sellers & Co., Inc., Philadelphia, Pa.
14.—W. H. Warren Machine Tool Works, Worcester, Mass.

the spindle sleeve is brought into contact with a trip latch, which, upon being depressed, releases a spring in the reverse rod, and causes the spindle to reverse and back out the tap.

The machines are furnished with either a plain or friction countershaft, and a plain or universal table, each of which are made to tilt vertically, as well as turn around on their bases.

Cuts and description, together with a catalogue of their full line of manufacture, will gladly be supplied by the makers.

CINCINNATI RADIAL DRILL CO.

The drill shown in Fig. 4, on page 309. is manufactured by the Cincinnati Radial Drill Co., and has some features of special design that distinguish it from all other styles. The column which is mounted on a heavy ribbed base carries an outer column which is mounted on anti-friction rollers. The inner column extends to about one-half the height of the outer one and the two are firmly locked together by the partial turn of an eccentric lever. The locking device is of very rigid construction and consists of a V-shaped bored ring that encircles both columns at the base and which is firmly gripped to both by the eccentric lever referred to.

An important feature in the stiffness of the machine is the detachable brace at the outer end of the arm. As will readily be understood this brace need only be used on heavy work, at other times it can be readily detached and moved upwards out of the way or taken off if desired.

The spindle is of steel, is graduated, and provided with roller bearings and bored for the No. Morse taper shank.

A feature that is of considerable convenience is that of the table swinging on the column so that it can be readily moved to the side when the work is to be placed on the bed. The brace at the outer end gives all the stiffness of the bed. The back gears can be thrown out and in when the drill is running and thus the operator is enabled to change the speed with a minimum of trouble and effort which often means the saving of much time on some classes of work.

The head has a long bearing and is moved on the rail by a hand-wheel that is conveniently located at the front of the head and not at the awkward position at the end of the arm.

DRESES, MUELLER & CO., CINCINNATI, O.

The radial drills made by this company were designed with the distinct object in view of enabling the operator to start, stop or reverse the spindle or to throw the back gears in or out without leaving his station, or having to reach for the counter-shaft.

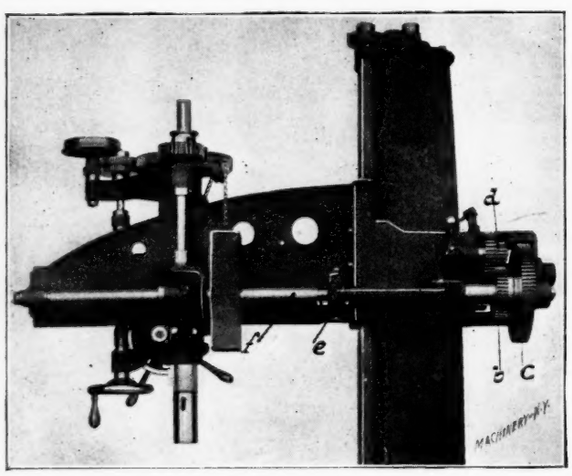


FIG 15.

To understand the method used for accomplishing these results it will be necessary to follow out the various connections used to impart motion to the drill spindle by the aid of the group illustration and of the illustration shown above, which is a back view of the arm of the drill.

Referring to the larger view, Fig. 5, the drive is through the cone pulleys and a vertical shaft in the inner column. The column is slotted at the rear which allows connection to be made between the vertical shaft and the gearing carried by the bracket which surrounds the column and which is supported by the swinging arm.

A short horizontal shaft, which receives its motion from the vertical shaft in the column, is journaled in the bracket and on this shaft is a compound gear, a. This gear turns with its shaft but is capable of sliding upon it and its two parts mesh with a large and small gear, c and b, respectively, which are on the horizontal shaft at the rear of the arm, from which shaft the spindle obtains its motion. Gears c and b run loose on their shaft and are alternately attached to it by a friction clutch operated by the lever, h, situated at the left-hand end of the radial arm, as seen from the front. This lever extends through the arm

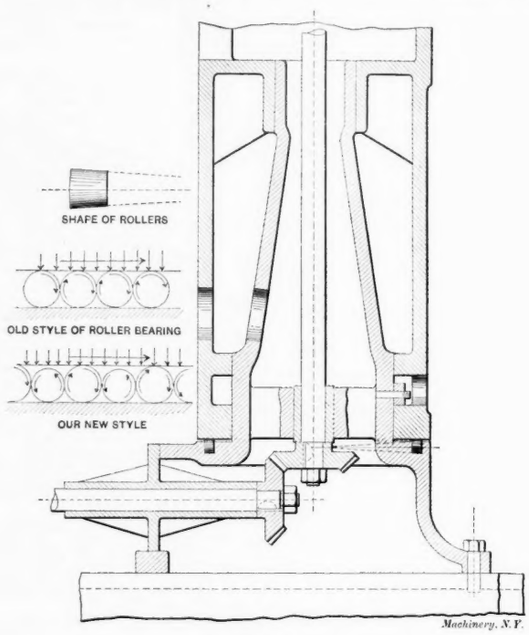


FIG. 16.

and can be seen in the rear view at e. By operating the lever h, which is at all times within reach of the workman, two speeds may be obtained while the machine is running which correspond to the direct and back-gear speeds of the ordinary machine tool.

For tapping there is an arrangement whereby the same handle h may be made to back out the tap without danger of breaking it. When there is tapping to be done, the compound gear a is slid along its shaft to the right, which throws the large gear out of mesh with its mate. The pinion of the compound gear, however, remains in mesh with its mate since it is of double length Another compound gear d, which is on an eccentric pin at the rear of the other gearing, is then brought into mesh with both of the disengaged gears, with the result that when the handle h is moved in one direction the drill spindle turns at the regular back-gear speed and when moved in the opposite direction the spindle reverses and runs backward at an increased speed. The friction clutch is self-adjusting and the gripping power can be so regulated that it will slip at a certain point and avoid breaking taps when they bottom.

The feed can be engaged or disengaged by a clutch operated by the lever seen above the feed worm, and the feed changes are easily made.

The column rests upon a novel form of roller bearing which is shown in Fig. 16. The train of rolls consists alternately of large and small rolls which eliminate entirely the friction between the adjoining rolls which have the load to carry. This style of radial drill is at present made in four sizes.

FITCHBURG MACHINE WORKS, FITCHBURG, MASS.

The radial drill as made by this company is shown in the group of photographs. It is of the well-known and approved type in which the swinging arm is suspended from a saddle which is raised or lowered on the column by power, and the drill spindle is belt driven.

The range of speed is from 1 to 27 7, and the drill is intended to be speeded so that the spindle will have a range of from 10.8 to 300 revolutions per minute. The countershaft has two friction pulleys, one of which is to be used for reversing when tapping. The arm is six feet long, has roller bearings and the ma-

chine is provided with the usual conveniences for handling found on the better grade of tools of this class.

The feed works are shown in detail in the line cut herewith. This mechanism is driven from a worm on the spindle through the worm-wheel A loose on shaft S. Worm-wheel A and pinion B are pinned together so that they turn as one gear. When the knob at the left is so moved that the pin X causes gear B to be locked with shaft S, the drive is through the two sets of cone

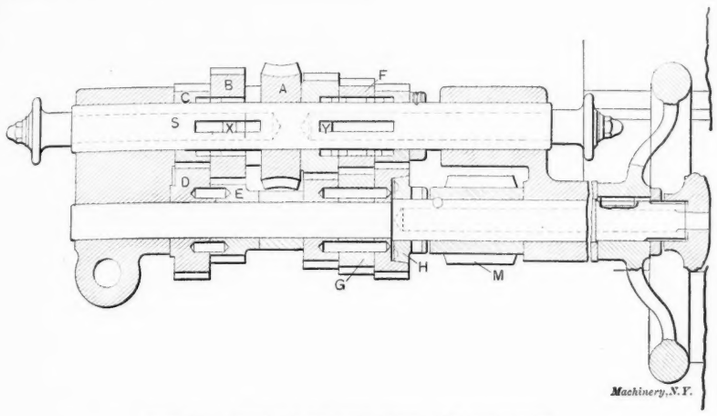


FIG. 17. DETAILS OF THE FEED ARRANGEMENT.

gears at F and G, any one of the gears in group F driving the corresponding gear in group G, according to the position in which the locking-pin Y is placed. When the friction clutch at H is clamped, the gears at G will then transfer the motion to the worm indicated at M, which in turn drives the feed-rod.

In case, however, other changes of the feed are desired that are not procurable with the above arrangement, the pin X is so

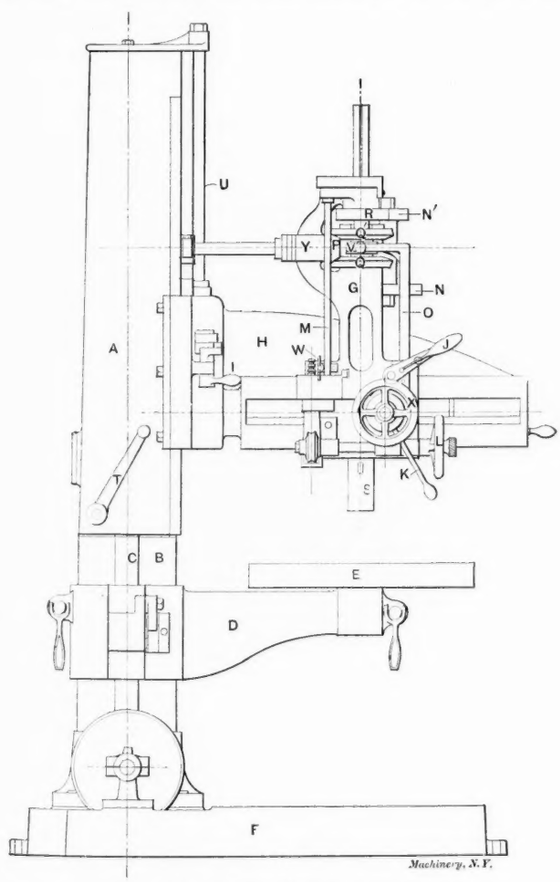


FIG. 18. DETAILS OF THE DRILL.

moved that pinion C will be locked to the shaft S in which case the drive will be through gears B, E, D and C before the cone gears finally receive their motion. This gives in all six changes of speed, all of which are positive.

WILLIAM E. GANG & CO., CINCINNATI, O.

One of the radial drills made by this firm is illustrated in Fig. 7, page 309, and they have also sent a blue print which is reproduced herewith, showing more in detail the general arrangement of the parts. The illustration made from the photograph and the detail sketch, Fig. 18 on this page, are of their No. O—60" style B drill.

Referring to Fig. 18, column A is turned on its lower end to fit stump B; it revolves on steel balls and can be clamped in any position by lever T, which operates a powerful clamping device in the interior of the column. The radial arm H is gibbed to the column and has large wearing surfaces. It is raised and lowered by power by means of a stationary screw and revolving nut, the elevating mechanism being operated by the handle I.

The spindle-head is gibbed to the arm and is adjusted on the arm by means of a rack and pinion and hand-wheel X. The bearing Y is fitted with a taper bronze sleeve which is adjustable to compensate for wear. All necessary operating levers are on the head convenient to the operator.

A feature of this drill is the arrangement of the mechanism whereby the spindle can be started, stopped, reversed and the back-gears engaged or disengaged by means of the operating lever J, while the machine is running. The action of this mechanism is as follows:

The spindle is driven from the bevel pinion P, which engages with the bevel gears Q and Q'. These two gears are loose upon the drill spindle and rotate in opposite directions in consequence of being on opposite sides of driving pinion P. The double clutch V between the two bevel gears is splined and keyed to the drill spindle so that it can slide upon it but must turn with it. This clutch can be raised or lowered by the handle J and the forked rod O so as to engage with either of the bevel gears or to be entirely free from either of them. The movement of the clutch, therefore, can be made to give the spindle motion in either direction or to stop it entirely.

The back gears are shown at N and N'. The lower gear engages with a pinion on the hub of bevel gear Q and to the upper one meshes with R. To throw in the back gears the clutch V is raised to its extreme position by throwing over the handle J which thus engages with R and the power of the back gears is transmitted to the clutch, which is keyed to the spindle.

The machine has a gear feed transmitted through shaft M and the rate of the feed can be changed by the lever W, which causes any one of the several gears to drive as desired.

The table arm D which supports the table E is adjustable vertically by a rack and pinion and can be swung clear around the column. This feature of a table in connection with a radial drill is one that makes the tool of increased utility for ordinary shop work since it adapts it to do the work of an upright drill.

EDWIN HARRINGTON, SON & CO., INC., PHILADELPHIA.

The Harrington drill illustrated in the group of photographs is of the 60 inch size, made to drill to a center of 102 inches. The traverse of the spindle is 20 inches and the table raises or lowers 14 inches, the vertical adjustment necessary for a drill of this size being obtained in this way instead of by raising or lowering the arm.

This size of drill is especially adapted to railroad work, the arm and column being heavily ribbed to insure ample stiffness for the heaviest work. The radial arm swings all the way around the column and is supported by roller bearings. A 48-inch drill is also made, which will drill to a center of 82 inches diameter, and is designed to meet the requirements of ordinary machine shop practice.

It will be noted from the illustration that there are several novel features of construction. The spindle and all works connected with it are enclosed in a casing and a self-oiling reservoir is formed inside ensuring lubrication of the washers.

The counterbalance consists of a weight sliding on the outside of the spindle casing where it is free from interference from any of the working parts of the machine.

The feed is through a cluster of bevel gears which are shown in detail in Fig. 19. Any one of the three small bevels is locked

to the driving shaft by sliding the rod R, which carries the pin P as is ordinarily done when spur gears are used on this principle. The feed is thrown out by an eccentric motion which moves the

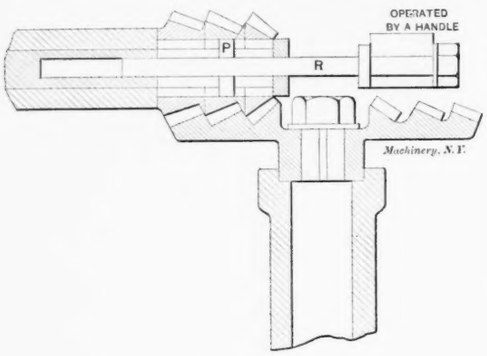


FIG. 19.

worm on the vertical feed shaft out of contact with the worm-wheel. There is a quick return for the spindle and all the operating handles are placed so as to be easily accessible.

THE NILES TOOL WORKS CO.

The line of radial drills manufactured by this well-known firm is represented on page 308, by Fig. 9, which is one of their standard forms having the new form of head. In the general description the manufacturers state that the drill is so constructed that the floor is left entirely clear and the arm may swing to any point. There are no belts or driving gears to interfere with placing the work. The column is bored out inside and fitted over a large post, which is firmly bolted to the sole-plate. The weight of the column rests on an elastic pivot made adjustable, so that when the column base-bolts are tight the base rests on the sole-plate, but when the bolts are loosened the column rises slightly and will turn very freely. The arm is very stiff, is guided on the column by a long split sleeve, has clamp-bolts for fixing it firmly in position and is raised and lowered by power. The drill-head is easily adjustable on the arm, and is balanced when spindle is down so that no danger is incurred by loosening the swivel-bolts. Hand and power feeds are provided. The countershaft is provided with tight and loose pulleys, and, when desired, furnished with a third pulley for reversing. A vertical splined shaft extends downward from the counter to center of column, and will suit any ordinary height of counter without alteration.

It will be noted that the cone pulleys are a permanent fixture to the arm and raise and fall with any change in its height. The operator thus has the means of easily and quickly changing the speed of the spindle without using a shifter pole.

The machine shown is not the full universal type, but they can furnish drills of this style if required.

The head of their new drill is made to swivel with a counter-balanced spindle, the spindle running in a sleeve or quill supplied with rack for feeding purposes. This is an excellent arrangement particularly in connection with tapping. Spindle is furnished with extra quick return and positive gear feeds. The gear feed is a feature peculiar to their tools and is found to be essential in doing the heavy work for which these tools are intended. It will be noted that there are no overhanging feed cones carrying narrow belts, which are always objectionable.

THE POND MACHINE TOOL CO., PLAINFIELD, N. J.

The radial drill made by the Pond Machine Tool Co. is illustrated in Fig. 12.

The vertical travel of the spindle is 18", and that of the arm is 48". At the extreme upper position of the spindle the distance from the floor plate to the end of the spindle is 89". The longest radius swept by the spindle is 72", and the shortest is 16". The same description applies to the 60", the various dimensions being the same with the exception of the longest radius of the spindle being 60", instead of 72".

These drills can be set at right angles or parallel with the line shaft, and in general, are very heavy and substantial tools, having many features of convenience.

The traverse of the saddle on the swinging arm, and of the spindle, which is counterbalanced, is by means of rack and pinion so placed that workmen can operate both and swing the arm at the same time, enabling him to bring the drill to the work more readily and with greater ease than with other machines of this class. Automatic friction feed with six changes.

The belt is applied to a pulley locked to the spindle. The back gears are arranged the same as on a lathe and as readily thrown in or out. Thus, for ordinary drilling, the smooth motion given by a belt is obtained, and for heavy drilling, the power obtained by the use of the back gears is applied directly to the spindle.

PRENTICE BROS. CO., WORCESTER, MASS.

Prentice Bros. Co. have sent us two photographs which are reproduced in Figs. 10 and 11 and illustrate respectively their standard and universal types of radial drill. The information which they furnished relates more particularly to the general design and construction of their tools than to the arrangement of the mechanical details. They write: "The base-plates are heavily ribbed, the columns of ample dimensions and of suitable shape to withstand the working strain; all operating levers and handwheels are within easy grasp of the operator; the back-gearing is applied directly to the spindle to relieve the driving shafts from strain; the radial arm swings on ball bearings and has a quick motion for locking it in any position; the head is movable along the radial arm by a spiral pinion (self-locking the head in any position); the feed gearing has uniform differences; there is a method of driving by friction reversing pulleys at either side or back of the column and the machine is shaft-driven throughout. Planed bevel gears are used (not rotary cut).

They build the common form of radial drilling machine in six sizes and the universal style in one. It will be seen from Fig. 11 that in the latter machine the spindle swivels on the end of the radial arm and that this arm slides in or out, being guided by ways which are a part of the saddle. The saddle slides up or down on the column and the latter swings on the column base.

In response to our request Prentice Bros. Co. furnished us with the following data relative to the speeds and feeds which they use. Assuming these to be fair average values for well-designed machines of these sizes, they will be of interest to any readers who have any drilling to do or any estimating in this line:

Drill.	Diameter Spindle	Morse Taper.	Counter Speed.	Spindle Speeds.		Feeds per One Rev. of Spindle.
				Back Gears out.	Back Gears in.	
No. 0.	1⅞	4	250	255	48	.0103
				171	32	.0262
				116	22	.0060
				77	14	.0154
No. 1.	2¼	4	225	186	38	.0048
				132	29	.0074
				92	19	.0123
				65	13	.0189

WILLIAM SELLERS & CO., INC., PHILADELPHIA.

In thees machines, one of which is illustrated in Fig. 13, page 309, the arm is hinged to a saddle carried upon the face of the column or upright, and is easily rotated by hand or raised or lowered by power by means of the hand-lever at the base of the upright. The saddle which carries the arm is of such length that it does not require clamping to position for ordinary work, rendering this adjustment of height extremely simple.

The spindle of the drill slides in a long, cast-iron sleeve, held in bearings top and bottom and is counterbalanced by a weighted lever. The feed is by means of a screw at the upper end of the spindle instead of by the more usual rack and pinion, the arrangement being such that the thrust is taken on a small hardened step at the center of the spindle instead of by large collars as is usually the case.

The feed motion is driven through a set of friction discs running at relatively high speeds and is adjustable through the range of useful feeds by means of a lever. The pitch of the feed-screw is 1½ inch pitch so that the motion of the hand-wheel produces a very rapid traverse of the spindle for the quick return. The feed is engaged by closing a clutch on the feed shaft which is done by the latch handle immediately over the hand-wheel, the latch serving to hold the clutch out of gear when the feed is not in use. The teeth on the clutch are V-shaped and of such an angle that they will not slide apart and yet so sharp that they will enter at any point.

The drive for the spindle is by belt throughout. As stated, the spindle slides in the sleeve. The latter rotates in the head and is driven by a belt which passes over the vertical shaft.

around an idler which it embraces for about 90°, thence around a pulley on the sleeve, around a second idler about which it makes a half turn, thence to the end of the arm where it passes around a tightening pulley and finally back to the driving shaft. By this arrangement the tension in the belt is always the same whatever the position of the head. The back-gears are placed on an eccentric shaft by means of which they may be disengaged.

The head is fed along the arm by a spiral pinion engaging with a rack on the lower surface of the arm, and the latter can be easily clamped in position if desired, but when the drills used are correctly formed and run true, this is not necessary.

An examination of the photograph will show that there is a convenient arrangement of the operating parts, all the adjustments and movements being accomplished by the operator without changing his position. The machine is made in several sizes.

WM. H. WARREN MACHINE TOOL WORKS, WORCESTER, MASS.

This is one of the New England companies, whose radial drills have been favorably known for many years. One of the five sizes of the drills which they manufacture is illustrated in Fig. 14 and it will be noted that the construction is quite different in some respects from any that have previously been described. In any radial drill there are, aside from the feed of the spindle, three adjustments for bringing the spindle in line with the work. The arm must raise or lower, must swing about the column, and the head must travel along the arm. In the case of universal radial drills, the spindle must also swivel so that a hole can be drilled at any angle desired. In the Warren drill the arm, instead of swinging from the saddle, as is the most common construction, is arranged to swivel on the saddle about a horizontal axis, which gives the universal feature. The saddle itself slides up or down the vertical bed B, which has planed vees, similar to a lathe bed, for the saddle to travel upon. The bed B swings on the column, as shown, and is supported by a ball thrust bearing at the bottom.

This construction makes it possible to convert the drill into a convenient horizontal drilling machine and the broad bearing on the vertical bed gives accurate alignment in any position.

These drills are regularly made in sizes 8′, 6′, 5½′, 4½′ and 3½′, all universal except the latter. The back gears can be thrown in or out by one movement of the lever C, the quick return and feed work equally well in all positions of the spindle and the driving bevel gears have planed teeth. All T slots in the base and portable table are cut from the solid stock. The countershaft has two friction pulleys, one of which is to be used for reversing when tapping.

* * *

AT THE NATIONAL MUSEUM.

The first steam engine to be erected on the American continent was set up at Belleville, near Newark, N. J., in 1753. Part of the cylinder of the engine is now at the National Museum at Washington, D. C., but it has been subjected to so much wear and exposure that it is not possible to judge as to the quality of the workmanship. It is very noticeable, however, that mechanics were not perfect in the "good old times" any more than they are now-a-days, for mistakes were made in drilling the flange of the cylinder and extra holes had to be drilled "off center" to correspond with the part of the machine that joined the flange.

Another interesting exhibit at this museum relates to dividing wheels, a subject which most mechanics probably associate entirely with modern shop practice. Nevertheless, a mechanic and scientist by the name of Jesse Ramsden made a machine in 1775 for cutting the teeth of a hob which he afterwards used to hob the teeth of the large worm-wheel of a dividing engine. The machine is provided with change gears similar to an engine lathe and is said to be the first example of the principle now used in screw cutting. The wheel of the dividing engine has 2,160 teeth and it would be a good problem for some of the bright young mechanics of to-day, who are expected to be well informed in such matters, to make all the calculations necessary for designing the hob and worm-wheel and the machines for cutting them. Both the lathe for cutting the hob and the dividing engine are in a good state of preservation and have a new and modern look about them.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

AN ADJUSTABLE ANGLE BLOCK, ETC.

Mr. W. F. Oliver, Plainfield, N. J., sends a sketch of an angle block and also one of a planer jack that has proven useful. The view given in Fig. 1 shows the angle block. He says:

"I have found it very useful around drill-presses and milling-machines. On work which is to be drilled or milled on an angle, I find a 6″ square a handy size for milling-machines and a 10″ square the best for drill-presses.

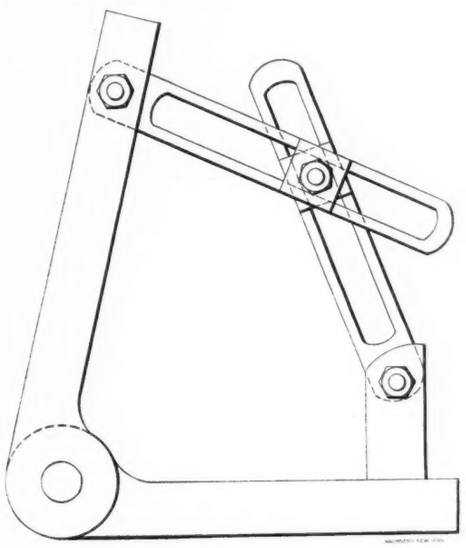


FIG. 1.

"To make the jack I drill a hole in the side at A, Fig. 2, ⅛″ larger than the screw B and put a freely fitted plug in the hole A. I then drill and tap a hole through the plug for the screw B.

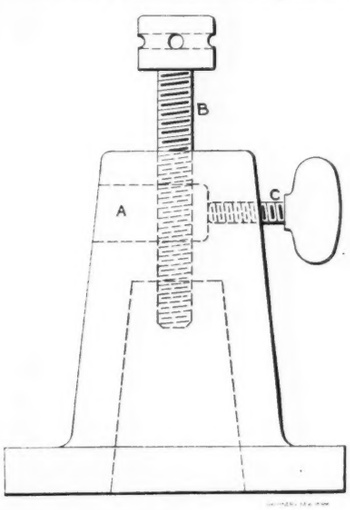


FIG. 2

A small hole is drilled on the opposite side of the jack for the thumb-screw C. The thumb-screw can be tightened when the jack is set at any desired height and the screw B thereby locked in position."

A SELF-OILING BEARING.

A simple form of bearing that insures a constant supply of oil where it is needed, is described by Mr. Wilfred J. Thompson, Toronto, Can., in the following words:

"For small work running at high speed, the cheapest and cleanest self-oiling bearing I ever saw, was made by drilling and reaming out a solid casting to the size of shaft. Then drill a hole about ⅜″ in diameter through the casting, near the bottom of and parallel to the reamed bearing, leaving about 1-32″ of metal be-

tween the two holes as shown in Fig. 3. Now saw or file this carefully through and round off the edges, fill the hole loosely with a strip of sponge allowing it to project into the bearing, and press lightly all along the spindle when it is in place. If oil not too thick is used, the sponge will act as a reservoir and keep the

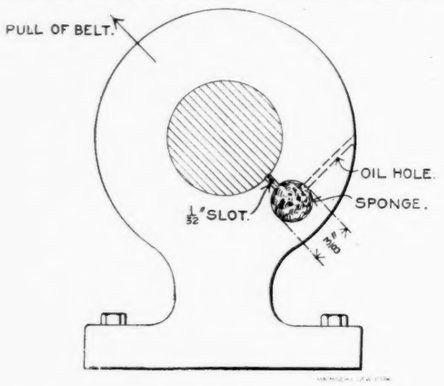


FIG. 3.

journal well oiled and also 'beautifully' clean. This oil chamber is best put opposite the pull of belt and it may have an oil hole drilled into it, but don't drill the usual oil hole in the top of casting as it is unnecessary and admits grit.

ABOUT THE SQUARE REAMER, ETC.

Mr. James P. Hayes, of Meriden, Conn., refers to his contribution to the Shop Kinks in the April MACHINERY and says:

"I neglected to speak of a way of making the square reamer which I described. In flattening the round steel to make the ream-

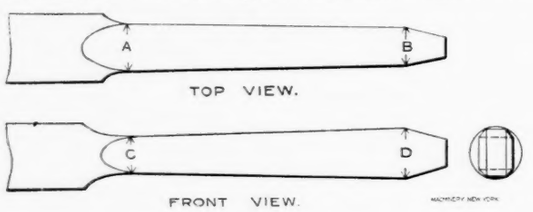


FIG. 4.

er, it should be made as shown in Fig. 4. A should be wider than B in top view and C should be narrower than D in front view, leaving the corners from 1-32" to 1-16" wide to be honed up after hardening. Made in this way two of the cutting edges have a

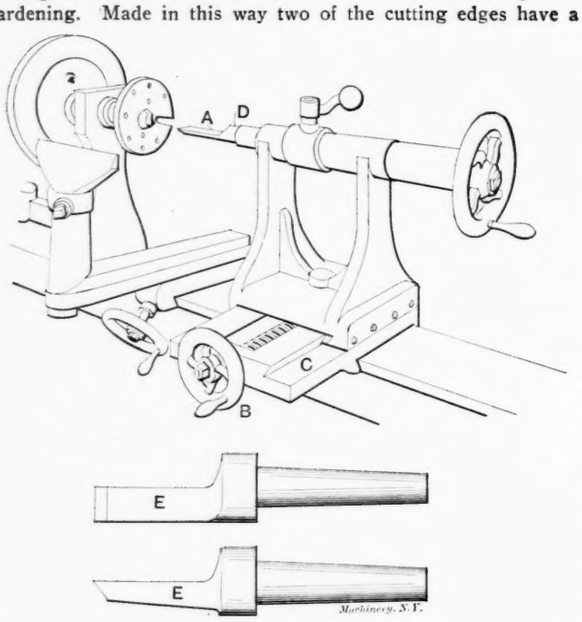


FIG. 5.

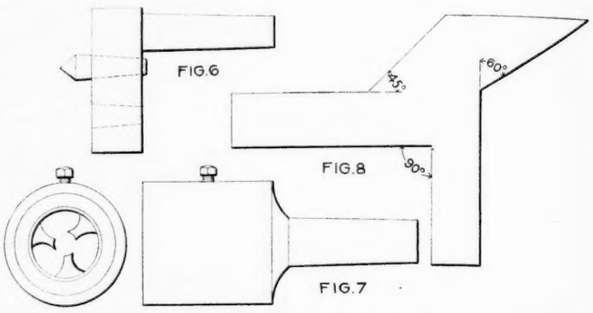
slight right hand spiral and the other two a left hand one which makes it cut smoother. Reamers made in this way have been used for reaming the chambers in revolver cylinders where a very slight scratch would condemn them. A large percentage of cylinders was lost until this kink was stumbled on. It was noticed that reamers made carelessly with no attention being paid to regularity worked the best.

"Fig. 5 is a sketch of a wood-workers' lathe in use in this shop. The special feature of this lathe is the tail-stock which, in connection with tool shown at E,E, is used for boring any size hole in work held on the face plate. The tail-stock is movable at right angles to the lathe bed by a screw and hand-wheel and is also movable lengthwise of lathe the same as in any other lathe. The tail-stock screw and spindle are extra long. The tool E is inserted in the spindle in place of the dead center and is offset so as to allow the tail spindle to clear in boring a long hole. Work may be faced and turned on the outside by a tool held in the tail spindle. This arrangement of tail-stock is spoken of very highly by the man who uses it."

SOME SHOP NOTES FROM LOUISVILLE.

Mr. George L. Renneisen, of Louisville, Ky., furnishes a batch of shop notes in which he says:

"I enclose a few kinks picked up in a small repair shop where it was my good fortune to begin my apprenticeship. In Fig. 6 is shown a center for turning taper work, to take the place of the tail-stock center. As shown in the sketch, there are two holes reamed in the ear of the center which in this case are 1" and 2" from the center. An auxiliary center is provided to fit in the holes



and the arrangement admits of a wide range on special work. In Fig 7 is shown a die-holder to be used in the live center of a lathe which should have a hollow spindle for long work. It can be made any size to fit the standard dies found in every shop, and will be found a great time saver in a small shop not equipped with a modern bolt cutter.

"A lamp bracket was made by our toolmaker, which will be appreciated by every mechanic and will save a lot of weird and foul language. It is easily constructed, being made of gas pipe and a piece of 5-16" round iron and fastened to the bench by a screw. A slotted board at the end of the arm holds the lamp in position. Fig. 8 is a tool which every machinist needs some time or other and then he needs it badly, yet it is found in the tool-chests of but few machinists. As will be seen it combines the three angles, 90° or square, 60° or hexagon, and 45° or octagon, and is made of a piece of sheet steel about 1-16" thick. A few minutes during some noon hour will make it.

"A cheap substitute for the boring tool described by 'Subscriber,' in the February issue, can be made by forging a piece of iron or steel into the proper shape and drilling and squaring a hole near the end for a piece of air hardening steel, which is held by a set screw. One of the holders is very convenient for boring large work as the bar can be forged very heavy but the tool need weigh only a few ounces.

JIG FOR DRILLING A DIE.

Mr. J. R. Shortt, of Toronto Junc., Can., gives us the benefit of some of his tool-making experience in the following letter:

"Enclosed please find sketch, Fig. 9, of a jig for drilling a die both for blanking and perforating. The blank is of the style shown at D and the method of using and making it is as follows: From the drawing of the blanks I make a fly-cutter which will correspond with the space between the sections, and use the cutter for milling the jig. It also answers as a template for filing the die and also for milling the punch for the die. I make the jig about 5-16" thick with a boss on both sides, one boss E corresponding with the center hole in the blank and the other F with the diameter at the bottom of space between the sections. In one section of the jig I drill a hole or holes which may be necessary to complete perforation in blank, and in the other sec-

tions as many holes as I will need to remove the stock from the die. For the blank I have to use a drill in the jig about 3-64" less in diameter than what the blank will stand, but this is immaterial as the holes are started perfectly in the center of the blank outline, which permits me to follow with a drill very close to size without the fear of running outside the line.

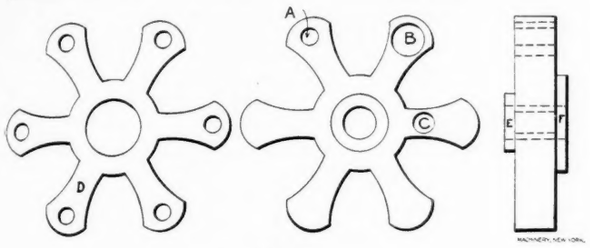


FIG. 9.

"I line off from my template first and then rotate jig and fasten opposite each section until I have completed the circle. For fastening the jig on the die, I use a small screw which passes through the jig and fastens in a nut at the bottom of the die. The gain is that I can drill closer to size and in the case of the blank end being a curve the diameter of which is the same or less than width of blank, I can drill *every* section at an equal distance from center and broach the holes to a finish which is almost impossible when one attempts to center drill from a prick punch mark. The same will also apply to the perforating operation as by using the same cutter as a template for the punch saves 90 per cent. in time in fitting same in the die and if anything happens to the punch you are able to duplicate it at the shortest notice. Some tool-makers might prefer, however, to use a sheet steel template and in fact I do myself sometimes but, in a case of that kind and also where I want to get some blanks to experiment with before finishing the die, I put the jig on a mandrel and clamp the sheet steel against the face of it and mill in that position."

A QUICK AND TRUE WAY OF FACING NUTS—REMOVING TIGHT NUTS.

"Old Subscriber" sends a kink for the benefit of some of the younger men that are learning the art of facing nuts, and illustrates it by Fig. 10. The sketch shows how to make a tool and chuck to face a nut true with the thread, and also face and chamfer the nut at one setting of the tool. The nut mandrel or chuck should have the thread cut on a taper which should not be less than that of a Morse taper shank drill. Nuts varying 1-32" in size can be faced true on such a mandrel but they cannot be done successfully on a straight threaded mandrel. The tool is nothing but a common side-tool with the front end ground to suit the angle of chamfer of the nut, the part A being used for

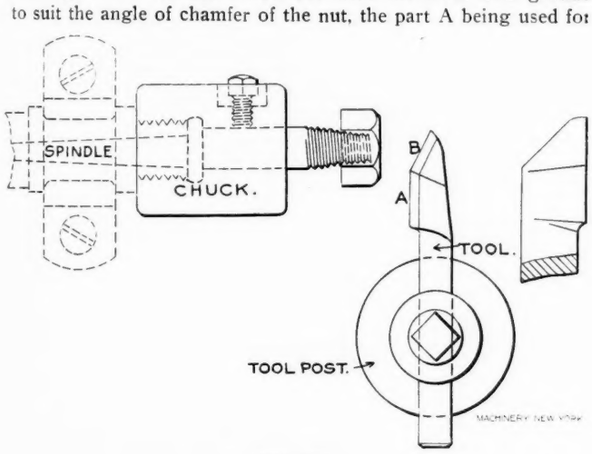


FIG. 10.

facing and the part B for chamfering. The above may not be new to some, but it may be interesting to the younger fellows who have advanced only thus far in their apprenticeship.

Another kink which is an important point in repair work is the removal of old tight nuts without breaking the studs. Every machinist that ever has had anything to do with some old engine or any other repair job has had more or less trouble with tight, rusty nuts and the breaking off of studs in the castings. In the above sketch I show you my way of getting over the trouble. If I find that a nut is too tight, I take a thin chisel and put it with the grain on one side of the nut and give it a few light blows which will split the nut. It may happen that the grain cannot be seen or it may be a steel nut which has no grain at all. If this be the case, it will only take a few more blows and you will save the stud from breaking and avoid the trouble of drilling out the old broken piece. Of course the nut is no good after being split,

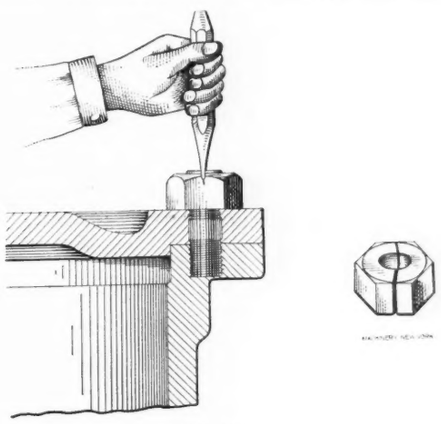


FIG. 11.

but as all nuts are standard nowadays, it is no trouble to get a new one even out in the country. It often happens that there is no way of getting at the back of the bolts, and if the nut happens to be tight, it is likely to put one out of temper trying to get it off, but by splitting the nut, much bad language is saved and also a lot of time.

A TOOL FOR SETTING DOWEL PINS.

Mr. H. B. McCabe, of Cleveland, O., sends the following description of a simple tool that will be found to be useful and convenient to have in the tool box.

The sketch shows a set which I use in many cases for putting in small dowel pins. This tool when placed over the pin and given a sharp blow with the hammer, firmly fixes the pin in place.

Several of these can be made to suit the different sizes of dowel pins most used, and they will soon pay for themselves.

By the use of this set dowel pins can be readily made fast in holes reamed with a reamer, the same size as the drill rod from which the drills are cut. I think the tool is especially handy where dowels are to be fastened in thin pieces, such as gauges for dies or the like, tools which are made of sheet metal.

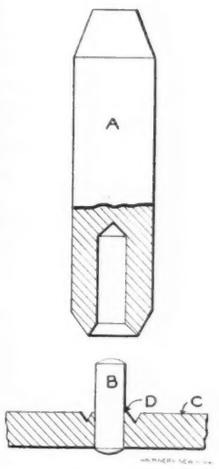


FIG. 12.

THE LOOSE PULLEY BUSH.

We are informed by Mr. J. D. Weir that a mistake was made in the description of the loose pulley bush illustrated in the Shop Kinks for March. The grooves were not cut from the inside, neither were oil holes drilled but slots were sawed through the shell by a circular saw or large mill to within a reasonable distance of each end.

He states that this construction proves reliable under the most trying conditions.

We will take this opportunity to emphasize the desirability of our correspondents making their descriptions as clear as possible. Do not be afraid of making your letters too long as it is easier to cut them down than to build them up and to supply missing points in the details.

* * *

When drilling large holes in a weak machine time can be saved by drilling a small hole first and then following it with the larger size. The small drill can be run at a higher speed and time required for the first operation will be more than offset by the time saved in the last besides greatly relieving the strain on the machine.

LETTERS UPON PRACTICAL SUBJECTS.

SOME PULLEY TALK.

Editor MACHINERY:

Some years ago I was called to W—— to fit a key to a 60" main pulley. When I reached the place, the engineer told me that he had a key fitted to the pulley about every two weeks and that he had to set it up every night. I took out the old key and found that it had a good bearing the whole length and said to the engineer: "I don't see anything wrong with this key, I cannot make you a better one." He said, however, that it did not hold and he wanted a new one. I looked at the job a while, found that the pulley was about 1-64" loose upon the shaft, and then knew at once that this was the cause of all the trouble. I sat down on an old candle box and thought what would be the best way of getting over the trouble with the least expense and while so thinking, said to myself, "This pulley has not got half as much to do as it appears to have, and I am sure that I have done more pulling with a common lathe dog, so why is it that this pulley can't do it?" Lathe dogs do not fit at all, and as I reasoned, I remembered that in one shop we had a home-made lathe dog, Fig. 2, which I could never make hold well if the piece was much smaller than the hole in the dog. I started to compare Figs. No. 1 and No. 2 together and found that Fig. 1 had three bearings while the Fig. 2 had only two. I compared the pulley with dog No. 2 and made up my mind to fix up the pulley with three bearings, same as dog No. 1. I then took the pulley off the shaft to true up the keyseat and after it was off, marked three places, A, B, C, and started to file out on D low enough to avoid the shaft touching as shown in the exaggerated sketch Fig. 3. After filing it so that the shaft would only touch at B and C, I put the pulley back and laid a piece of tin under the same old key and drove it home. This pulley has never worked loose, and it is four years since I fixed it. The engineer don't know what I did to it, but he thinks I am the only one who knows how to fit a key.

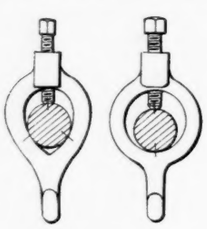


FIG. 1

FIG. 2

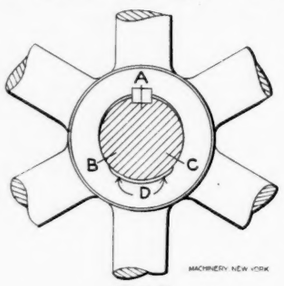


FIG. 3

J. D.

* * *

TO KEEP HARDENING WATER COOL.

Editor MACHINERY:

Some years ago, I had charge of a small machine shop and in our regular work we had a number of large pieces of steel to harden in a small blacksmith shop, having only a common fire and a large barrel of water as instruments to work with. My blacksmith was an experienced man on steel and very careful, always using good judgment. The pieces were five inches in diameter at the largest part and three inches at the smallest with small fillets at the shoulder, as shown in Fig. 1, and the section five inches in diameter and eight inches long was the only part that needed to be hard.

When I took charge of the shop we were sending these pieces to a large manufacturing establishment which made a specialty of hardening and they returned the majority of them to us hard and in good condition although, of course, they lost some in the hardening process. The only thing objectionable about it was the fact that we had to pay what I considered a high price for the work and, in case of breakages, of course, the price was the same.

I consulted with my blacksmith and he informed me that he had been trying for a long time to get running water in the blacksmith shop, and said if he could only get that he had no doubt but what he could have as good success as the firm we were now sending the pieces to. With the barrel of water he now had, as soon as he plunged a piece, the temperature of the water would rise so fast that in a few seconds it would be almost worthless for hardening, but by introducing running water he hoped to keep the water in the barrel cool, thereby insuring success.

Upon examination I found that for a number of reasons it would be impossible to get city water to the shop and immediately looked about for some substitute, and finally decided upon the following plan.

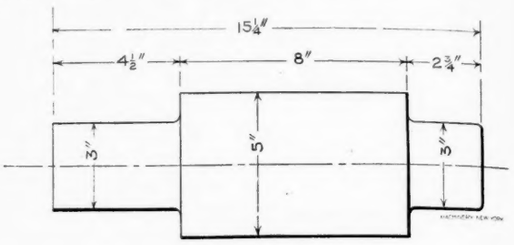


FIG. 1.

I took the barrel which he had been using and placed it on a shelf high enough to avoid interfering with the men in any way and put in its place a hogshead, sinking it into the ground so that the top of it was about on a level with the top of the forge, as shown in Fig. 2. From the upper barrel to within about three inches of the bottom of the hogshead, I ran an inch and one-half pipe with a straight way valve, with lever conveniently placed, so that it could be opened as soon as a piece was plunged into the hogshead. In the back of the hogshead I cut an aperture about twelve inches wide and six inches down, and built a wooden trough to lead from this opening to a barrel which had been placed at the left and sunk into the ground so that the top was flush with the flooring. Having the hogshead filled to the bottom of this opening with brine, and the barrel on the shelf above also full, when the steel was plunged into the brine the valve could be opened and water from the upper barrel admitted to the hogshead, the surplus amount flowing, by means of the wooden trough, to the barrel on the left.

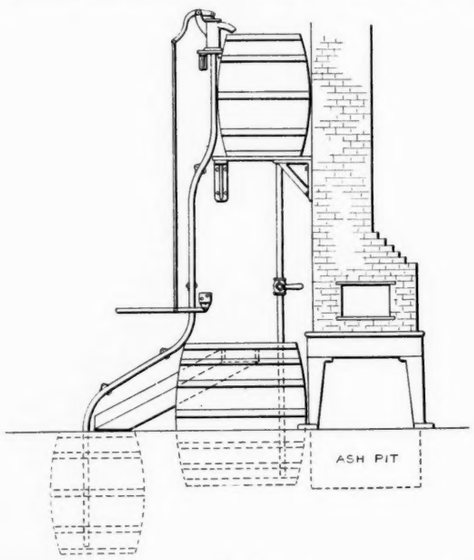


FIG. 2.

The water from the upper barrel, entering the hogshead at or near the bottom, answers a two-fold purpose; first, the heated water will naturally rise to the top of the cask and the water entering at the bottom will force this warm water out, thus keeping the water in the cask cool, which was the primary object of the device. Second, the water entering as it does disturbs the deposit of salt at the bottom of the hogshead, thereby increasing the strength of the brine. As a proof that the warm water flows off, and the cold water remains, it might be said that after an operation, the water in the barrel to the left is several degrees warmer than the water in the hogshead. This water is returned to the barrel above by means of the pump, shown in sketch, which is operated by the blacksmith's helper.

Four bushels of salt to a hogshead of water is about the

strength of brine we used and an addition, occasionally of a half bushel of salt and a few pails of water, from a neighboring building, keeps the strength of the brine and the supply of water constant.

The pieces were heated in a charcoal fire; the charcoal being banked entirely about the piece and the greatest care used to get an even heat and to work it up slowly. When a light cherry color was obtained the piece was plunged into the brine and the valve opened to admit the water from the barrel above. It was gripped by the tongs at the end of the long shank and was moved about in the water, by the blacksmith and his helper, and not allowed to touch either bottom or side of the cask. The piece was kept in the water until it was possible to place the hand on it and was then put into a can of oil and allowed to stay about five minutes when it was taken out and wrapped in waste and burlap until it resembled an Egyptian mummy. After being wrapped up it was buried in the ashes, in the ash pit, under the forge, and not disturbed for twenty-four hours at least.

We found the pieces treated in this manner hard and in good condition and as a rule very seldom lost one.

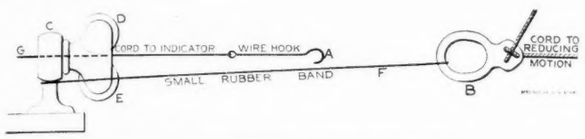
A. B. BABBITT.

* * *

CATCHING THE CORD.

Editor MACHINERY:

I noticed in May number of MACHINERY, page 267, a device for indicator cords, which interested me. Directly under it was an editorial asking readers to reciprocate and give the editor a chance to print any novel ideas which might be read with interest by the "other fellow."



DEVICE FOR CATCHING INDICATOR CORD.

The device mentioned brought to my mind a "kink" which I have been using for a number of years, and which I think is original with myself. It is very convenient, and as to cost, it is as near "something for nothing" as you can get. I enclose a rough sketch and description, which you can use. The operation is as follows: A small rubber band, such as used by druggists, on small packages, is fastened to the eye or hook on the cord leading to the reducing motion, and the other end is placed on the indicator so as to pull "fair" as far as possible. When the cord is unhooked the tension of the rubber band will hold the eye in the proper place so that it can be readily caught again when it is desired to make connections. WILL BETTIS.

Houston, Texas.

* * *

SOMETHING ABOUT THE LOW TAIL STOCK.

Editor MACHINERY:

Many manufacturers of lathes follow the practice of making the tail stock of a lathe lower than the spindle head, so as to allow for wear. As a rule, the machinist finds no fault with this practice and he does not see that it makes very much difference if it is a little lower.

I will tell you, however, of the experience that I once had on some work bored on a lathe with a low tail stock that enlightened me on the subject. I was running a 36" lathe at that time and had a job of boring some elevator casings which had a worm gear and worm wheel inside. The lower part where the worm shaft works is shown at E, Fig. 1, the other part of the casing not being shown. I had to bore and face the lower end of the casing, and I blocked it down on the carriage in the usual way and bored the hole with a regular boring bar with one cutter, and after roughing out the hole I faced the flanges to make it more simple. I have indicated only a common cutter B in my sketch, but the tool I used was the regular facing rig with star feed. After facing the flanges, I took a finishing cut through the hole. Another man had the job of boring and facing the heads C and D as shown in the lower figure.

When the floor hand got hold of the job he laid out the holes in the heads and casing and bolted them on with the shaft in the holes. The shaft was a nice fit in the flanges, but as soon as the screws were tightened, the shaft became tight and the floor man took off the head and started to file out the holes in the heads. As soon as the lathe hand who faced the heads saw him do that, he went to the floor man and asked him why he was filing out the heads. He remarked that there was something "out of line." By this time, I got there too and of course blamed the man who bored the heads for not using a true mandrel. He said that his mandrel was true enough for this job or any other job, and I went over to his lathe and saw it run. The mandrel was true, but what could be the matter? I knew that my casing did not shift in the lathe but I noticed afterward while I was boring some more of the same casings that the floor-hand had to file everyone, no matter how careful I was. Finally, I said to myself I wonder if the tail stock is to one side and found that it was a very little but I could not see that this should make any difference, the cutter was stationary and even if the cutter was a little to one side, it would not make any difference, as the hole would come out parallel with the ways of the lathe. I finally took a pice of chalk and made a sketch showing the center lines of E and the lathe as shown in the lower figure, and found that I was right that the hole would be parallel with the ways of the lathe, but when I put a cutter B on the end of the flanges, I found that the face would be at right angles with the bar. I knew then that this caused all the trouble.

I chucked a piece about 2 feet long with a center on the other end and shimmed up my tail stock, got it central and

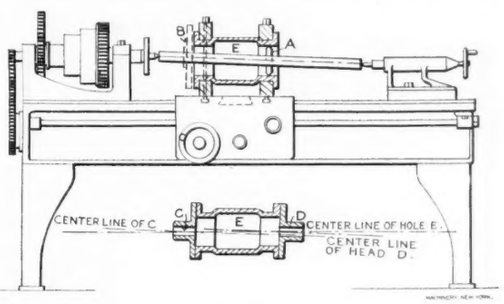


FIG. 1.

put in another casing and bored and faced it the same as before. After I got through with it I told the floor man to finish this one first, as I was anxious to see how it would come out and it proved to be all right. In the lower figure I have shown the heads in place and it will be easy to see that the holes are not in line, one is higher than the other. Of course, the sketch is very much exaggerated so as to plainly show the amount the holes are out of line. From this it will be seen what a low tail stock or one set to one side will do, when a job is put on the carriage and a boring bar used. There may be many machinists who have had cases similar to this who have blamed themselves or somebody else, when in fact there was no one to blame but the lathe. J. R.

[The point brought out by "J. R." is worthy of careful consideration as it is often the unsuspected source of much trouble on this class of lathe work. Another point, though of minor importance, is that holes bored with a bar out of alignment with the ways are not round but are slightly elliptical in shape. This feature is usually not prominent enough to cause any serious trouble unless the difference of alignment is considerable.

The lower sketch in Fig. 2 shows the outline of a cylinder with a bar through it which is out of alignment vertically with the ways and the angles are exaggerated so that the effect can be readily discerned. The line D F is at right angles to the axis A B of the boring bar and is the diameter of a hole that would be bored if the distance from the center of the bar to point of the tool were C D, and the direction of travel were along A B. But its projected distance in the direction of the bore of the cylinder, which is of course parallel with the ways of the lathe, is E C. Now E C. is evidently less than D C. but the upper view which is a plan of the cylinder with the boring bar in position, shows that the lines D F and E G must coincide in E G, so that the diameter bored is greater in a transverse direction than in the vertical.

With a bar 30" long and the tail center 3/8" out of line the amount of ellipticity in a hole 12" in diameter would be twice the difference between E C and D C.

C E D is a right angle, hence:

$$\overline{EC}^2 + \overline{ED}^2 = \overline{DC}^2 \text{ or}$$

$$36 + .005625 = \overline{DC}^2$$

$$DC = \sqrt{36.005625}$$

$$= 6.00047''$$

So that the diameter bored transversely is $2 \times 6.00047 = 12.00094$ and as the diameter in a vertical direction is 12" the difference is .00094 or practically one-thousandth of an inch.

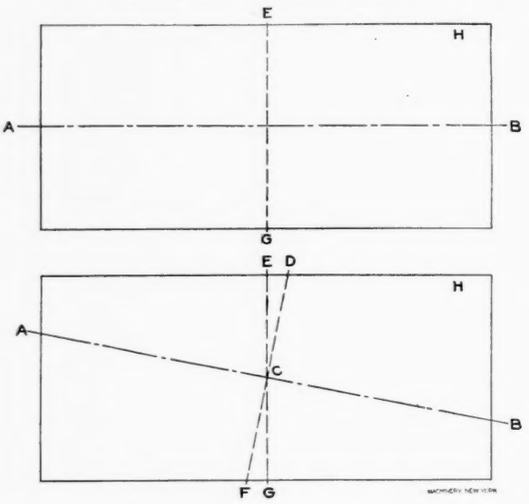


FIG. 2.

We think that "J. R.'s" method of lining the tail center is open to criticism as being unreliable in some instances, although it appears to have been all right in this case. As the box next to face plate of an old lathe wears the most and in a downward direction, the usual result is that the axial line is pitched downward in the direction of the tail center. Now by lining the tail stock by a piece held in a chuck the result would be that it would still be too low.

The safest way is to chuck the cylinder in place on the carriage and put the bar in position on the centers, then with the carriage to the extreme right, caliper from the inside of the cylinder to the under side of the bar and then run the carriage to the left and again caliper from the same spot in the cylinder to the bar and if not the same, line up until they are the same. Be careful that the bar is of the same diameter in both places. The same method can be used in getting the side alignment also.—[EDITOR.]

* * *

"CATCHING THE THREAD."

Editor MACHINERY:

The device for "Catching the Thread" described in the May issue of MACHINERY, ought to work all O. K. But any thread can be caught without this device, although perhaps, not quite so conveniently. I have cut quite a number of long screws by tripping the nut.

In one instance (when it was necessary temporarily to remove the reversing pulley on the line shaft), I had to cut all screws with no backing belt. Most of my fellow workmen when they had a screw to cut carefully avoided this lathe, and in a number of instances, after the work was set and the tool in position, upon missing the reversing belt, the workman would hunt up another lathe. As this same event under similar conditions would probably occur in other shops, it seems a good subject to write upon for MACHINERY.

The simplest way to catch the thread is to stop the lathe and run the carriage back the required distance by hand, this distance can be easily obtained by a little mental calculation.

The lead screws of engine lathes usually have some whole number of threads per inch, some lathes an even number, other lathes an odd one. If the lead screw has an even number of threads per inch and the screw to be cut has also an even number, the thread can be caught for every half inch, as it is evident that if the lathe be stopped and the carriage run back by hand one half inch, the tool and the nut will have passed over half their threads per inch, and the nut would close in the right place.

If the lead screw be an odd number, or the screw to be cut be an odd number of threads per inch the carriage must be moved an inch or any whole number of inches. If we are cutting a fractional thread as 11 1-2 threads per inch, we must run back a number of inches indicated by the denominator in this case 2 inches.

When tripping the nut with the lathe stopped, I usually put a chalk mark on the face-plate of the lathe so it will be vertical at the end of the cut, the carriage is then run back the required distance, measuring from any convenient point. A way to catch threads with the lathe running is to put a chalk mark or tell tale on the screw gear and another one on the face-plate, then if the lathe carriage be moved by hand to the same starting point, as when the gear and face-plate were marked, the nut can be thrown in when the marks come in the same position. The beginner should do this by hand. When the screw to be cut is the same pitch as the lead screw or any multiple of its pitch, the nut can be tripped anywhere.

JOHN T. GIDDINGS,

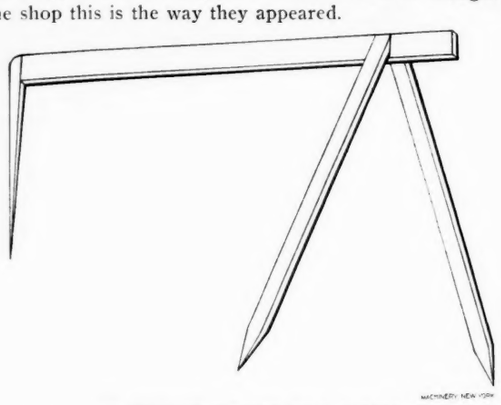
East Providence, R. I.

* * *

SIDE HILL BALANCING BARS.

Editor MACHINERY:

A short time ago I worked in a place where there had recently been a change in management and new shops built. One day I had some saw arbors to balance and asked for the balancing bars. I was informed that they were out in the shed at the end of the shop, so I sent a boy after them. When he brought them in the shop this is the way they appeared.



AN ADJUNCT TO SIDE HILL FLOORS.

I was somewhat in a hurry and this is the way the surrounding atmosphere appeared:

!!!! ---- ???? ---- " !! " (???) --- " " " " ! " " (" ")

I found out after some inquiry that these were all the balancing bars that the shop owned, but that they did not use them any more, having substituted the lathe bed and a couple of parallels.

The former foreman had made them like sketch because the old shop floor was out of level a couple of feet in its length and he used to adjust these bars by driving one or the other of the pointed legs into the shop floor with a sledge hammer. The old shop and foreman are gone, but the balancing bars remain as an illustration of how Yankee ingenuity (?) will overcome difficulties.

B. F. GROUT.

Sherbrooke, Que.

* * *

AN OMISSION.

Editor MACHINERY:

I wish to express my indebtedness to Seaton and Routhwaite's hand-book for the pitch and diameter formula which I laid down graphically in the article "Steam Power of Small Yachts," published in the MACHINERY for April. Through inadvertance I omitted to mention the origin of these formulas.

Richmond, Va. WILLIAM BURLINGHAM.

* * *

If it be wished to tap a hole slightly larger than the standard size, it can be easily accomplished by winding a few threads of waste around the point of the tap. The waste answers the same purpose as the tin or copper shim sometimes used for the same purpose and is simpler to use after the knack is once required.

PRACTICAL PROBLEMS.—8.

PROBLEMS 15 AND 16 WITH ANSWERS TO 13 AND 14.

Problem 15.—Required, the Angular Position of a Planer Head to Obtain a Certain Angle by a Combination of Cross and Down Feeds.

Mr. John Dunn, of Streator, Ill., sends a practical problem, which is one recently encountered in his shop practice and he states it as follows: It is required to plane a piece on an angle of 19 degrees from the planer table, but as the head cannot be swung around far enough to obtain it, the cross and down feeds must be used in combination with a required angular position of the swinging head.

The down feed screw has 6 threads per inch and is driven by miter gears while the gear on the outer end of the splined cross shaft has 15 teeth. The cross feed screw has 2½ threads per inch, and the gear on the screw has 20 teeth. The gears on the splined cross shaft and the cross feed screw both mesh with the gear that is driven by the feed ratchet. What is the required angular position of the head to obtain the angle of 19 degrees and, also one of 20 degrees.

Problem 16.—To Find the Relative Travel of I and A.

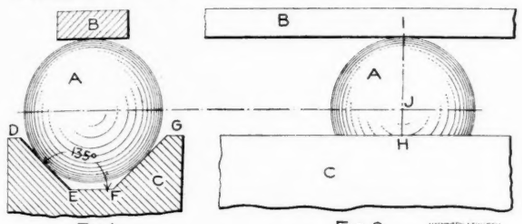


FIG. 1 FIG. 2

The ball A, which is 2″ in diameter, lies in a groove in the part C, as shown in Fig. 1. The inclination of the sides DE and GF to EF is equal and is 135 degrees. If the piece B be laid on the ball and be moved to the right in a direction parallel to C so that the ball shall roll between B and C, how far to the right of H will I be moved so that the center of the ball shall be 10″ to the right of H.

About the May Problems.

No correct solutions to the problems published in the MACHINERY for May have been received at the time of this writing; although a number of answers are at hand that vitally fail in accuracy.

PROBLEM 13.—The first problem for the May issue, No. 13 involves a number of important principles not the least of which is that of the conservation of energy. Some of the solutions gave results that manifestly showed that the velocity of the disc at the foot of the incline would represent an amount of stored energy four or five times greater than that due to its position at the top of the incline. It is evident that the correct result will be that one which, ignoring friction, would show an amount of energy or vis-viva that will exactly equal the energy of position of the disc at the start. The calculation of the kinetic energy has not however been made in the following solution, as it is not necessary, the velocities only being computed.

The disc occupies a position 14′ from the horizontal piece D and according to the laws that govern falling bodies its velocity would be 30.007 feet per second if it were allowed to fall freely from that height. This result is obtained from the formula $v = \sqrt{2gh}$ in which g is the velocity attained by any freely falling body in one second, and h is the distance through it falls. The value of g is usually taken to be 32.16 feet and as the height is 14 feet we find the velocity as given, by extracting the square root of 32.16×14, which gives the result of 30.007 feet per second.

The velocity of a body moving freely down an inclined plane and without friction is always equal to that it would attain in falling through a space equal to the vertical height of the incline. So that in this case if the disc were sliding (not rolling) down the incline it would have a velocity of 30.007 feet per second in a direction parallel with A. (See cut in May issue.)

A body rolling down an incline is, however, subject to a restraining action which modifies the result in a way which we will endeavor to explain as clearly as possible. In the first place a rotating disc of uniform thickness has a mean radius of gyration which is always equal to .7071 times the actual radius. Thus the mean radius of an emery wheel 20 inches in diameter is $.7071 \times 10$ or 7.071 inches which means simply that the weight of the entire wheel may be considered as concentrated in a circle 14.142 inches in diameter. Now if such a disc 24 inches in diameter were rolling down the inclined plane it would have two motions, one around its axis and the other a progressive motion along the direction of its travel. It is evident that each of these motions will require the expenditure of a certain amount of potential energy which is represented in this case by the disc's vertical height of 14 feet. Our calculated velocity of 30.007 must be so divided between the progressive action and the mean rotative action that the two results will satisfy the conditions that exist.

We will let x equal the velocity of the progressive action,

Then $\frac{16.9704x}{24}$ equals the velocity of the mean circle of rotation. Since different velocities are to each other as their respective squares, we have the equation

$$x^2 + \left(\frac{16.9704x}{24}\right)^2 = 30.007^2$$

Solving for x we find its value to be 24.5 feet per second. Now it is evident that the velocity of the periphery of the disc around its axis is equal to this amount so the square of the velocity of the mean diameter should equal the difference between 30.007^2 and 24.5^2 which it does as shown by the following:

Since the mean velocity of the disc is .7071 of that of the periphery then $(24.5 \times .7071)^2 = 300.11$. The square of 30.007 is 900.42 and the square of 24.5 is 600.28 so the difference is practically equal to 300.11 which proves our result.

In the problem as given, however, we have another feature that again modifies the result. The disc is supported on a smaller diameter than that of the periphery, being that of B which is only 4″ while that of C is 24″. We can, however, use the same method of finding the relative velocites of translation and of rotation which follows:

Let x = the progressive velocity, then since the mean diameter is $24 \times .7071 = 16.9704$ inches, the velocity of its periphery will be expressed by the ratio of the two diameters 4 inches and 16.9704, or $x \times \frac{16.9704}{4} = \frac{16.9704x}{4}$

Therefore using the same form of expression as before we have

$$x^2 + \left(\frac{16.9704x}{4}\right)^2 = 30.007^2$$

The square of 16.9704 equals 288 very nearly, hence

$$x^2 + \frac{288x^2}{16} = 900\ 42$$

$$16x^2 + 288x^2 = 14406.72$$
$$304x^2 = 14406.72$$
$$x^2 = 47.3905$$
$$x = 6.884 \text{ progressive velocity in feet per second.}$$
$$6.884 \times 6 = 41.304 \text{ rotative velocity in feet per feet per second of the periphery of the disc.}$$

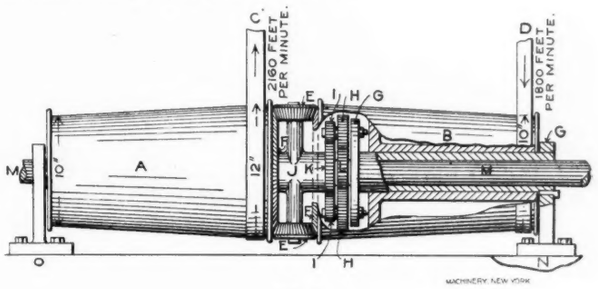


FIG. 3.

PROBLEM 14.—With the belts in the position shown in the cut the cone pulley marked A would have 687.55 rotations in one direction while the pulley marked B would have 687.55 rotations in the opposite direction in one minute. This being the case the bevel gears E, E would transmit no motion to J but would simply turn on their bearings with the consequent result that M would have no motion with the belts in the position shown.

With the belts in the middle of the cones the left hand cone A would rotate 750.05 times in a minute and the right hand cone would turn 625.04 times in a minute. The cross-arm J with the

gear K would consequently turn one-half the difference between 750.05 and 625.04 or 62.5 times in the same direction that A turns. This motion is multiplied through the gears K. I, H and L, by 5 since K has 48 teeth, I has 16 teeth, H 40 teeth and L has 24 teeth. Hence the number of rotations that M makes is 312.5 per minute. Now with the belts to the extreme left A will rotate 825.06 times per minute and B will turn 572.96 times in the same time. One-half the difference between the two is 126.05 which is the number of turns of K in a minute. $126.05 \times 5 = 630.25$ the number of rotations of M.

Mr. Fred S. English, of New London, Conn., sent in a solution to No. 11 too late to be published last month. He obtained a different result from that of Mr. Wenttengel's as he assumed that the bar passed entirely through the ball.

One of the problems given this month is contributed by one of our readers from actual shop practice and we shall be pleased to receive more of them.

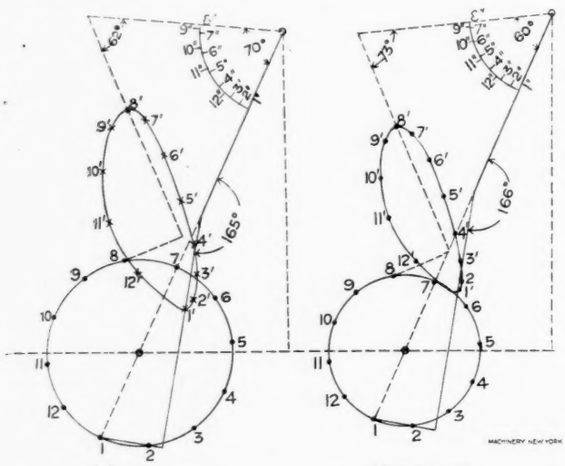
* * *

LONG AND SHORT CRANKS FOR BICYLES—WHICH?

HENRY HESS.

As the bicyle is, for the present, at any rate, propelled by man power, the question as to the relative advantages of long and short cranks for riding with the least fatigue cannot be definitely treated as a question of mechanics only. But if actual experiment in road riding and mechanical analysis should arrive at a similar result, then it would be fair to accept this as generally correct.

To determine the relative fatigue with long and short cranks, a bicycle with two crank holes was made use of. This was ridden by a member of that sex which lumps all machinery and cognate matters under the general head of "monkey wrenches;" it was, therefore, a very easy matter to see that the pedal was somtimes fastened to the inner and at other times to the outer hole of the crank, "unbeknownst." A systematic record was kept of the effect on the rider over the same roads; also, "unbeknownst," so that the effect of imagination was entirely eliminated. A study of this record showed a very decided superiority of the shorter crank as entailing less of "that tired feeling." This is showing No. 1 by experiment.



7½" CRANK. 6" CRANK.

Probably every one will agree that in order to walk with the least fatigue the muscles should be put through motions as nearly equal to those that ages of hereditary training have accustomed them to as possible. This means that that arrangement of the parts of a bicycle, which gives most nearly coincidence of the relative positions of the leg and thigh with those of walking will be best. The two figures illustrate this for a short and long crank of 6-inches and 7 1-2 inches, respectively. The dimensions are taken from the writer and his machine. The position adopted is such that the center line of the thigh continued passes through the crank shaft and pedal pin center, when the thigh is in its lowest position. The full lines show the thigh, leg and foot, in this position; the dotted lines show the same parts at the higher extreme. Measurement shows that with the 6-inch crank, the thigh rotates through an angle of 60 degrees, which is increased to 70 degrees by a change to a 7 1-2 inch crank. The change in angular relation of the thigh and lower leg is for the two cranks $166° - 73° = 93°$, and $165° - 62° = 103°$, respectively For both cases the movement is greater than that of walking naturally; it is safe to say, that every additional increment entails more than a porportionate increase in fatigue; showing No. 2 is also in favor of the shorter crank.

While the crank is being turned at a uniform rate, the motion of the leg and thigh is very variable, the rate is zero at the lowest and highest positions reached. If the leg and thigh are treated as elements of a machine, the work of moving them is that required to overcome their inertia, and is proportional to their weight and the square of their velocity.

By measurements, the weight of the lower leg and foot was determined roughly as two-thirds of that of the thigh. Similarly, the point of concentration of the moving weight of the lower leg (center of gyration) was found to lie at 1 (see the full-line representing the lower leg in the figure). The similar point for the thigh is marked 1". Dividing the crank path into twelve equal parts and plotting the corresponding positions, gives 1', 8', 12', as the path of the center of gyration for the lower leg, and 1", 8", 12", that for the thigh. The distance measured between successive points in these curves will be proportionate to the velocity from point to point.

Measuring the distances with a pair of dividers set to a comparatively small opening, gives figures tabulated below:

6 INCH CRANK.

Lower Leg.			Thigh.	
Points.	Spaces.	Spaces^2.	Spaces.	Spaces^2.
1 to 2	2.0.	4.00	1.8	3.24
2 to 3	3.5	12.25	2.0	4.00
3 to 4	4.8	23.04	2.3	5.29
4 to 5	6.0	36.00	2.4	5 76
5 to 6	6.3	39.69	2.8	7.84
6 to 7	5.8	33.64	2.3	5.29
7 to 8	3.2	10.24	.0	1.00
8 to 9	3.3	10.89	0.8	0.64
9 to 10	5.8	33.64	2.3	5.29
10 to 11	7.8	60.84	3.3	10.89
11 to 12	8.0	64.00	3.8	14.44
12 to 1	8.5	72.75	4.4	19.36
Sum.....		400.48		Sum, 83.04
Multipliers for relative weights.		⅔		1
Comparative figures.....		266.77		83.04
Sum for leg and thigh.....		349.81, say 350.		

7½ INCH CRANK.

Lower Leg.			Thigh.	
Points.	Spaces.	Spaces^2.	Spaces.	Spaces^2.
1 to 2	2.5	6.25	2.0	4.00
2 to 3	4.0	16.00	1.9	3.61
3 to 4	5.3	28.09	2.2	4.84
4 to 5	7.0	40.00	3.0	9.00
5 to 6	7.8	60.84	3.0	9.00
6 to 7	6.5	42.25	3.1	9.61
7 to 8	3.8	14.44	1.5	2.25
8 to 9	4.0	16.00	1.0	1.00
9 to 10	7.0	49.00	2.9	8.41
10 to 11	8.0	64.00	3.8	14.44
11 to 12	9.0	81.00	4.5	20.25
12 to 1	10.00	100.00	5.0	25.00
Sum		526.87		Sum, 11.41
Multipliers for relative weights.		¾		1
Comparative figures.....		384.58		111.41
Sum for leg and thigh.....		495.99, say 496.		

In these tables the first column gives the points in the curves, the second and fourth give the lengths spaced between successive points; the third and fifth give the square of these lengths. The squares are then summed up and multiplied by the factors proportionate to the relative weights of the lower leg and thigh. These products are then summed up. The resulting figures are proportional to the product of weight and square of velocity; that is to say, to the work required to move the leg and thigh. The results, 350 and 496 are very decidedly in favor of the shorter crank to which the smaller figure belongs.

* * *

A small lump of rosin thrown into melted babbitt just before pouring into a box will tend to prevent the throwing of the melted metal by the dampness that may be present. It should also be remembered that rusted surfaces in a cavity are sometimes more dangerous than the presence of a small quantity of free water.

NOTES BY A ROVING CONTRIBUTOR.—12.

ABOUT MACHINE PATTERNS - A TRADE OF TWO BRANCHES —WAGES AND DUPLICATION - VERTICAL AND HORIZONTAL ENGINES—REMARKS ON WAGON BRAKES.

In my notes respecting San Francisco shops, let it be set down that they know how to make patterns, and this is a good deal. They have a distinct natural advantage in the sequoia, or redwood, a wonderful timber for the purpose, that does not shrink perceptibly and is not affected by the moisture while in the mould or in the rain. This is a great help, but the main thing is the "contrivin'," as the Scotch call it. All the "dodges" of English foundries, and they are many, are known here and a good many more. Taking Philadelphia practice as an example for comparison, patterns are made here at less than half the cost for the same castings.

Circular forms, when concentric, as made with strikes or sweeps and volute forms, are strickled or made with "skeletons," as it is called here. At one place they were making a pattern for a large volute pump casting by nailing on layers about an inch square, bending them to the curves. This pattern was a duplicate of the casting. Circular cores are made in halves. I do not believe there is a double core box with duplicate sides in this city; perhaps ought not to be. A half box is cheap, simple and accessible. The half core has a flat face to fit on a plate in drying, keeps straight, and pasting together costs next to nothing. But little loam work is done here, but all large moulds are fire dried.

The art of cheap casting is divided between the foundry and pattern shop; in fact, the two are so intimately connected as to be branches of the same thing, with the difference, however, that the pattern maker's saving is a matter of tangible record, and the foundry's losses and gains, due to patterns, goes into the gross weight and does not appear, and here may come in some further discussion of the skill problem.

A good pattern-maker has two trades to learn. One culminates in a nice clear varnished pattern, so every joint and the grain of the wood stands out like a piece of furniture; corners filleted and rounded, core prints blacked, and the draught so accurate that the pattern would fall out of the sand if the mould were turned over. That is one trade. The other is to learn to make a pattern for the same purpose out of timber as it came from the mill, all shapes cut on a band saw, nailed up like a packing-box, covered with a coat of litharge and sent to the foundry at a cost of one-fifth as much as the first one described, and just as good for one or two castings, because the moulders will cut the fillets carefully and "slick up" a suspicious mould when a pattern is questionable. Perhaps the pattern-maker will dodge the whole matter by some sticks and strikes that furnish "indication," but in any case this is a second trade to be learned, and is not the easier of the two.

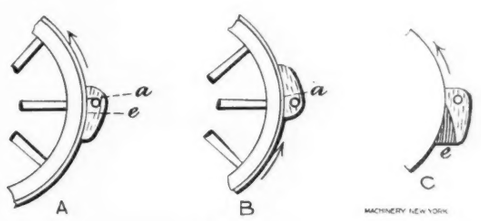
Here on the Pacific Coast are famous opportunities for studying the economics of production, things not seen by our younger mechanics, reared in an environment of organized industry and where the division of labor is complete. The orderly methods seem to them normal and natural. Perhaps they are, but organized production is new. It is also a sequence of wide markets, and is impossible without a wide market. There is no such market here, and the smaller ships do all kinds of odd work.

In an elevator works I visited, where their practice in that line was modern, and even more than that, the owners were obliged at times to prepare pipes, make pulleys and shafts, and to some extent their own machine tools, one of which will bear notice. It was a large sole plate, about twenty feet long, five or six feet wide, planed true and slotted. On one end was a boring head, with a spindle about twelve inches in diameter, driven on the overhang. They called it a boring machine, which it was in the full sense. There were many long hydraulic cylinders to bore, from 12 to 30 inches in diameter, and when these were off, the machine was put at work turning up rope pulleys, at a rate that was amazing. A whole groove was cut out at once with a shape tool, which the man at work on the machine said, was "all right if the spokes in the wheels would not pull out." He had six of them clamped for driving. There were powerful portable slide rests, and the huge machine had no rest.

By the way, a large sole plate, or a "geometric floor," as it may be called, has a wonderful place in a machine shop, not only for erecting, but forms the better half of a machine tool equipment. Boring, planing, and turning even, can be done all over a job, while everything can be "lined" from the floor or from angle plates. In the new erecting shops of the Union Iron Works, at San Francisco, a good share of the erecting floor is made of huge sole plates, planed true, lined and slotted. It cost a lot of money that is coming back in a rapid manner. To erect a marine engine on a floor of this kind is a totally different matter from setting it on blocks, and working without a base.

"Cold on the feet," some will think. Just the contrary. I once saw an iron floor in a machine shop in New Jersey, laid in cement, that was the only comfortable one in the works, for both summer and winter, never varying from the temperature of the earth, about 60 degrees. A new machine of 500 pounds weight could be slid about on this floor by one man. It was a pronounced success, and needs imitation. The walls, windows, doors, roof and beams of a machine shop are all determinable elements, but the floor is a problem. The wear falls there. It is the bearing surface, so to speak.

On the Pacific Coast wages are high because of the diversity of occupations; and if you do find a man producing duplicate commodities, such as bolts and nuts, his wages are on an Eastern basis. Most everything is made heavier here, and, in most cases, better, or more durable at least. It would be heresy, I presume, to say that there are running here some steam engines driving generators, that have the top record on this continent in uniformity of motion, steam distribution and economy of fuel. I will venture the opinion that a "science" of regulation was originated in connection with these engines, whether ever published or not I do not know. They were made by the Union Iron Works and had an especial interest to the "contributor," who, at Paris, in 1878, had the temerity to point out that the Oerlikon (Swiss) engines of the inverted marine type would become the prevailing one for generators. Here is the "Oerlikon" engine, refined in various ways, but identical in so far as type.



This is equivalent to saying that marine engineers are ahead in engine development, a proposition not difficult to maintain; or, to put it in another way, the marine men have struggled for forty years to perfect a type to drive propellers, and the electrical folks found ready made and appropriated the engines to drive their dynamos, which is practically the same kind of duty. It is not presumable that the editor or his readers care much for an opinion of mine, but I think it is about time that steam engine-makers should make their engines stand up and work, not lie down on their sides and require a curved piston rod to counteract gravity. There are plenty of logical reasons for vertical engines; perhaps some the other way; custom for one thing, and this is a powerful reason. I saw an example to-day of this latter component. Noticing the brake blocks on the wagons, the common form is indicated at A, in the fine drawing herewith. Taking into account the turning moment about the axis of the block, the center of impingement is about on the line a, and consequently the block below the line e is useless. If these blocks were reversed, as at B, the pressure would be distributed over their whole surface, but that is not the "custom." At C is shown a practical example noticed. The reinforcement at e consisted of old shoe soles or other leather lumber, nailed on. Still the architect of this work votes, and may be the chief officer of a society to determine the economic relations of skill as a factor in industrial production. I do not know that all wagon brake blocks are made this way; let us hope not.

* * *

The acme of shallow draft vessels seems to be reached by the Yarrow Company, of London. They have built for use on the Magdalena River one vessel, 150 feet long, with a draught of only 15 inches, and capable of a speed of 15 miles pe hour. Some of their smaller vessels have a draught of only 6 inches.

HENRY DAVID STONE.

One by one the old-time mechanics who laid the foundations for the present machine tool business of the country are passing away. Of these, Mr. Henry D. Stone, who died at Windsor, Vt., on May 11, was closely identified with the development of the turret lathe and to him is due the present type of turret lathe using an automatic turning turret with the operating mechanism enclosed beneath the turret. His invention dates from 1858. An automatic turning turret had been made before this but the index pin was located on top of the turret where it was exposed to chips and accurate work with it was impossible.

Mr. Stone was born at Plainfield, N. H., in 1815, and learned both the cabinet maker's and machinist's trade, beginning the latter apprenticeship when he was 21 years old. In 1846, he went to Windsor as a pattern maker for Robbins & Lawrence, one of the leading machine tool building firms of that time. Later he worked as draftsman and finally took charge of the shop. At that time they were making rifles for England in addition to a line of machine tools, running about 100 men in each department. This work was continued until October, 1856 when Robbins & Lawrence failed and Mr. Stone commenced with a Mr. Clark in the manufacture of sewing machines. From that time on Mr. Stone was the central figure around which clustered several enterprises culminating in the Jones & Lamson Co., formerly of Windsor, but now of Springfield, Vt. During the Civil War he was actively engaged in making guns and gun machinery.

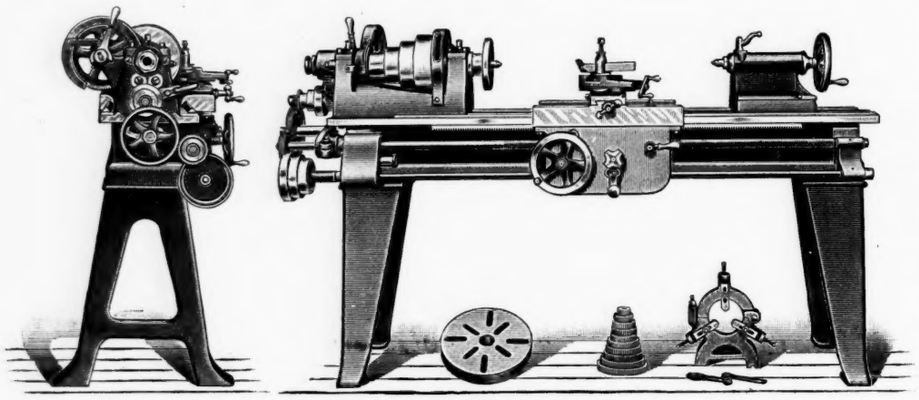
Mr. Stone's extensive experience in manufacturing guns and sewing machines impressed upon him the necessity for special machinery for manufacturing purposes and influenced him in his work upon the turret lathe. He designed many special machines for gun and sewing machine work, besides lathes, planers, and other standard machines and bore the reputation of being one of the best mechanics of his day.

* * *

NEW 14-INCH LATHE.

The accompanying illustrations show a new 14" lathe recently designed by Mr. W. C. Young, president of the W. C. Young Manufacturing Co., Worcester, Mass. It is an exceptionally heavy and powerful tool. The bed has box ties, is of unusual depth, and is made in even lengths from 6 to 10 feet. The headstock is very stiff, being webbed under the cone and has 1⅛" hollow spindle. The ratio of gearing is 10 to 1. The tail stock is of the cut-away type, allowing the compound rest to be operated when set parallel with the Vs, and has an extra large spindle. The carriage has a bearing of 20 inches on the Vs and is strong and carefully fitted.

The construction of the apron is such that the lateral and cross



14-INCH ENGINE LATHE.

feeds cannot be engaged at the same time. The lathe is provided with the improved compound rest lately brought out by Mr. Young and the tool is throughout uniform in design with the other sizes of lathes now made by this company. Gearing is furnished with the English lead screw for cutting threads from 4 to 36, including the pipe threads, and with a metric lead screw for cutting threads from 8mm to 1.5mm. It is also furnished with large and small face plates, center rest with hardened steel jaws, friction countershaft and the necessary wrenches.

ITEMS OF MECHANICAL INTEREST.

In the discussion of central heating plants at the Washington meeting referred to elsewhere, several interesting points were brought out. Mr. Kent suggested that where steam had to be carried for a long distance under ground there might be a reduction in the loss from radiation by using two pipe lines of different sizes. For example, if a ten-inch pipe was required in the winter time to carry the steam needed six and eight-inch pipes could be run, one for use in the summer, one for the fall and spring and both together to be used in the winter. He also suggested that the pipes could be placed in a tunnel through which air for the furnaces might be forced to supply a warm draft.

A point brought out by W. S. Rogers in relation to the equipment of universities did not miss the head of the nail very widely. The colleges, he said, try to run things on too economical a basis, when it would pay to waste a little money. They fit up model plants with the most economical machinery in order to show the boys how to do it. "Put in a few rotary and oscillating engines and show them how not to do it." They have to meet with crude and delapidated machinery when they get out in practice and make it pay dividends and an essential part of their education is that they know how to do this. Oberlin Smith followed with the remark that he had recently visited a college where some of the patterns and other beautiful works of art that the students had made were used as fuel under the boilers and he suggested that some arrangement be made whereby some of these pieces could be utilized to better advantage by manufacturers.

AN INTERESTING EXHIBIT.

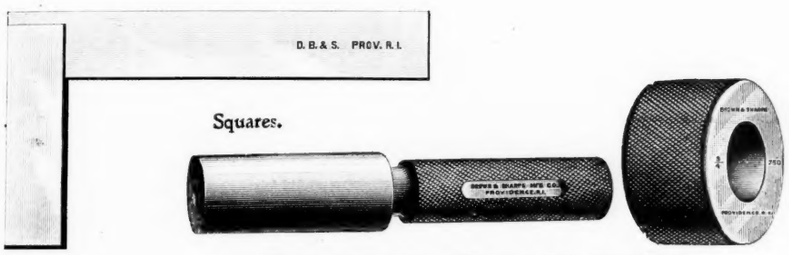
Power users who have been troubled with slipping belts on their machinery have usually at some time or other tried with indifferent success one or more of the many preparations that are on the market for curing the evil. It has become, in consequence, almost an unwritten law in many plants, that nothing shall be put on a belt except possibly an occasional dressing of neatsfoot oil as so many compounds have so signally failed in results, unless it be to ruin the belt. It was with pleasure, therefore, that the writer was enabled recently at the Electrical Exhibition in this city to see a practical demonstration of the merits of Cling Surface.

The exhibit was so arranged that power was taken from an electric motor and transmitted to two small dynamos by parallel belts of the same width, the respective pulleys for each being of the same size. One belt had been treated with the preparation and the other one was running under ordinary conditions. The dynamos were precisely alike in every respect and generated current for two banks of incandescent lamps, one set being arranged to read "With Cling Surface" and the other "Without Cling Surface." The dynamos were mounted on trucks and the tension was given by Fairbank's spring balances, which indicated that the belt running without the preparation was under nearly double the tension of the other; in fact, the the treated belt was practically under no tension at all when not running, the tension on the spring balance only indicating the pull of the belt necessary to drive the dynamo. The treated belt was running so loosely that the slack nearly touched the tight side, giving it a remarkable appearance. The truck carrying the dynamo that was driven by the treated belt could be surged back and forth a considerable distance without affecting the brightness of its lights, a momentary flicker being noted when the slack side touched the opposite one, but the least change in the tension of the untreated belt was instantly indicated in the brightness of the "Without Cling Surface" sign.

BROWN & SHARPE MFG. CO.,

. . . Providence, R. I., U. S. A.

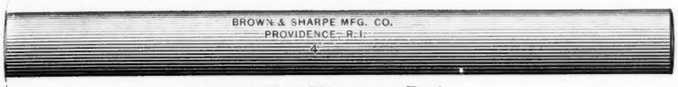
ACCURATE TEST TOOLS.



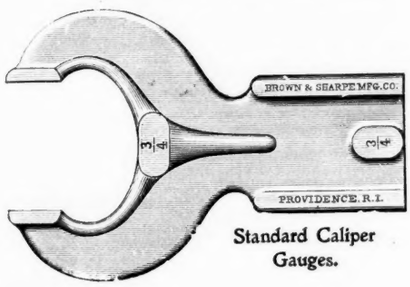
Squares.

Standard Internal and External Cylindrical Gauges.

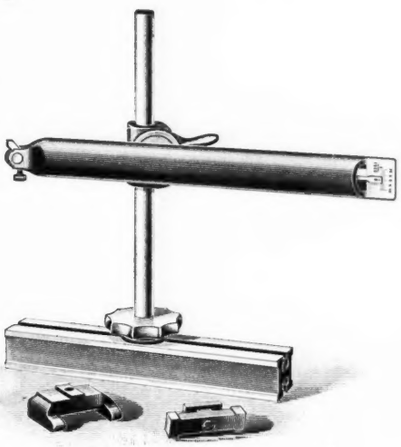
Standard Reference Discs.



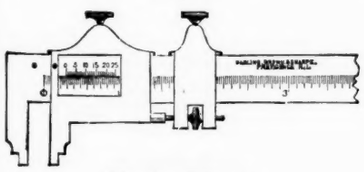
Standard End Measuring Rods.



Standard Caliper Gauges.

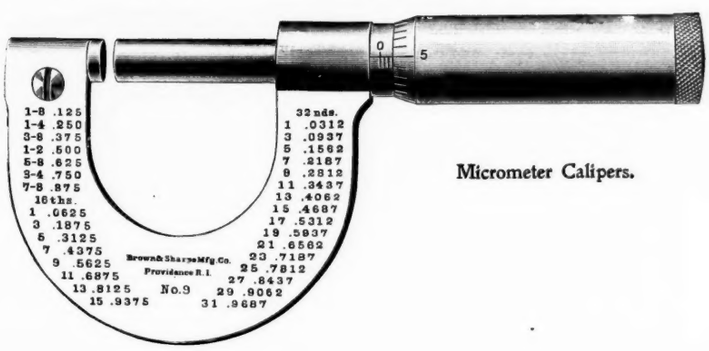


Test Indicator.



Vernier Calipers.

Rules.



Micrometer Calipers.

Catalogue mailed to any address upon application . . .

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

98. F.W.G. desires a description of a graphical method for finding the correct radius of a Stephenson link when the outline is scribed on a board or other smooth surface. A. The best and most practical method is to find the center of the outside arc by trial, using a pair of trammel points or trams for the purpose. The inner arc may be used but the outer one being longer, the center can be located more accurately. The only description of the operation that can be given is to find by repeated trials a center from which with a certain distance between the points of the trams for a radius an arc can be described that shall exactly

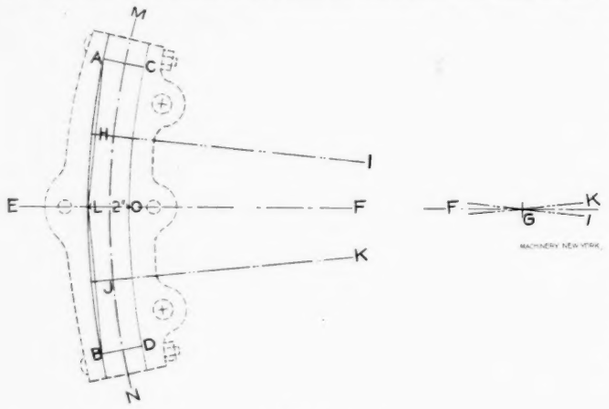


FIG. 1.

coincide with the scribed outline of the link in all points. This method will require a certain amount of experienced skill on the part of the workman. Another method which is a geometrical solution of the problem is to draw the two chords AL and LB and erect the perpendiculars IH and KJ at their middle points as shown in Fig. 1. The intersection of these lines at G locates the center of the arc whose radius may then be measured. The radius of the link is one-half the distance LO less, that is the distance from G to the arc MN is the true radius. The first method is, however, the most satisfactory and easiest of accomplishment but one-half the distance between the inside and outside arcs must be taken from the radius found the same as in the latter method.

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99. F.A.D. asks if four wheels securely fastened to a shaft and of the proportions indicated in Fig. 2 can roll in harmony on a straight track, the two inner wheels being in contact with the rails of a narrower gauge track as shown. A. By the question it is evident that the meaning is whether the wheels will roll without any of them slipping on their respective tracks. The answer

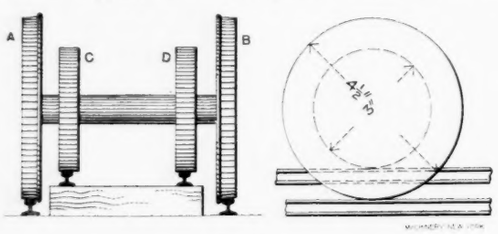

FIG. 2.

to this question is so self-evident and so easily proven by trial that it is something of a puzzle to understand why it was asked. It is easily understood that the wheels A and B will travel a distance equal to 3.1416 times the diameter 4′ 6″ or 14.1372′ in one revolution when in contact with the outside tracks, but it is equally as plain that if the wheels C and D be in contact with their rails that they will roll only 3.1416 times 3′ or 9.4248′ so that there is an evident discrepancy of 4.7124′ in the travel of the two pairs of wheels that can only be compensated by the slipping of one or the other of the pairs of wheels. From this it is evident that they cannot roll in harmony.

FRESH FROM THE PRESS.

LIQUID AIR AND THE LIQUEFACTION OF GASES, by T. O'Connor Sloane. Published by Norman W. Henley & Son, New York. 365 pages with many illustrations and portraits. Price, $2.50.

This interesting work contains seventeen chapters, the first of which is on physics and contains the rather startling statement that the theory of conservation of force is an abandoned doctrine. The author, however, indicates the difference between force and energy in a remarkably clear manner, showing that force and energy are not necessarily the same, although often erroneously taken to be. Then follows a chapter on heat, which is chiefly devoted to the different methods of measuring it, with a full description of the hydrogen thermometer, which has a range from the temperature of liquefied gases to that of melting glass.

The third chapter takes up the subject of heat and gases and gives some interesting facts concerning the effect of the removal of heat from gases when accompanied by heavy pressure. The efforts of some early experimenters to liquefy air were unsuccessful because they failed to reach the "critical temperature," the enormous pressures developed in the attempt being valueless unless a corresponding critical point in the temperature be attained.

On the other hand, however, any gas may, it is believed, be liquefied without pressure if a sufficient reduction in the temperature be reached. It is shown that a gas may be so compressed above the "critical temperature" that it will occupy the same space in the form of a gas that it does when liquefied.

The greater part of the work is given to the biography of some of the leading scientists and experimenters who have made a study of this branch of physics, together with accounts of their researches.

The work is one that will repay a careful perusal and is particularly adapted to the non-technical reader, being written in a simple and clear style.

EASY LESSONS IN MECHANICAL DRAWING AND MACHINE DESIGN, arranged for self instruction by J. G. A. Meyer. Published by the Arnold Publishing House, 16 Thomas street, New York. Volume 1, 405 octavo pages, fully illustrated. Price, $7.50.

This is the first bound volume of the course in mechanical drawing for mechanics and draftsmen. The several sections of which the volume is composed have been noticed in these columns from time to time as they have appeared. A second volume, which is now in preparation, will complete the course, and it is safe to say that when both volumes have been issued they will make the most valuable single work that any mechanic, interested in machine shop practice, can own. Two sections of the second volume have already been issued.

To give a general idea of the scope of the work we will state briefly what the character of the contents is without attempting to cover the whole ground treated of in the lessons. Three courses of study are carried along simultaneously. The first takes up geometrical and mechanical drawing; the second consists of practical exercises in machine design, and the third gives practical rules and useful data for those who wish to learn how to make the calculations that most often arise in practical constructive work. In all three sections the explanations are given fully, even to the smallest details, so that no one who is attempting to study by himself at home need have the slightest trouble in understanding just what is meant.

The course in drawing covers the subjects usually included in text books upon this subject, but it treats of the various problems more fully than we have seen elsewhere.

The exercises in machine design give practice in proportioning the parts of some of the most used machines, such as engine lathes, steam engines and various small parts like bolts, wrenches, cotters, etc. The practical rules and useful data include exercises in plain geometry, strength of materials, the calculation of pulley speeds and diameters, levers, and various subjects in mechanics are also covered.

As we have already said in reviewing some of the earlier sections of this work, if any young mechanic in starting with his apprenticeship in the shop would also carry on a course of study during the winter evenings, using Prof. Meyer's book as a textbook, he would, if he studied faithfully, have a good practical education by the time he was ready to start as a journeyman.

THE STEAM ENGINE INDICATOR by F. R. Lowe, editor of Power. Published by the Power Publishing Co., World Building, New York. 208 8 vo. pages, illustrated. Price, $1.50.

It may seem to the casual observer that at this day there is not room for another work upon the steam engine indicator. The ground has been well covered, and there are a number of excellent books treating of the subject. We feel sure, however, that this new book is one that will be appreciated by many from the fact that it treats of certain phases of work with the indicator and of steam engine economy that are not usually discussed in books of this class. The usual subjects of care and selection of the instrument, the method of applying it, its errors, the characteristics of indicator cards, the method of computing horse-power, etc., are fully and clearly treated. In addition to these usual subjects the book contains, as we have mentioned, discussions upon subjects of a more general character.

We are glad to find that the author does not follow the usual